INSTRUCTION MANUAL

MODEL 190

20 MHz
FUNCTION GENERATOR

WAVETEK

WAVETEK SAN DIEGO, INC.

9045 Balboa Ave., San Diego, CA 92123

INSTRUCTION MANUAL

MODEL 190
20 MHz
FUNCTION GENERATOR

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SAFETY

This instrument is wired for earth grounding via the facility power wiring. Do not bypass earth grounding with two wire extension cords, plug adapters, etc.

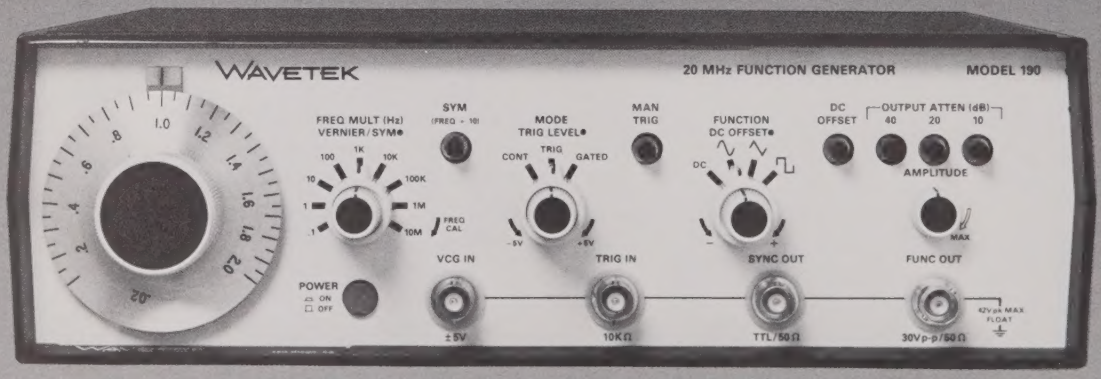
BEFORE PLUGGING IN the instrument, comply with installation instructions.

MAINTENANCE may require power on with the instrument covers removed. This should be done only by qualified personnel aware of the electrical hazards.

The instrument power receptacle is connected to the instrument safety earth terminal with a green/yellow wire. Do not alter this connection. (Reference: ⏚ or ⚠ stamped inside the rear panel near the safety earth terminal.)

WARNING notes call attention to possible injury or death hazards in subsequent operations.

CAUTION notes call attention to possible equipment damage in subsequent operations.


WAVETEK
20 MHz FUNCTION GENERATOR
MODEL 190
FREQ MULT (Hz)
VERNIER/SYM
SYM
(FREQ ÷ 10)
MODE
TRIG LEVEL
CONT
TRIG
GATED
MAN
TRIG
FUNCTION
DC OFFSET
DC
DC
OFFSET
OUTPUT ATTEN (dB)
40
20
10
AMPLITUDE
MAX
FREQ
CAL
POWER
ON
OFF
VCG IN
TRIG IN
SYNC OUT
FUNC OUT
±5V
10KΩ
TTL/50Ω
30Vp-p/50Ω
42V pk MAX
FLOAT

SECTION 1
GENERAL DESCRIPTION

1.1 MODEL 190

The Wavetek Model 190, 20 MHz Function Generator, is a precision source of sine, triangle and square waveforms plus dc voltage. All waveforms are front panel variable from .002 Hz to 20 MHz and can be externally modulated. Outputs can be continuous or the generator can be triggered or gated by an external signal or a front panel switch. Amplitude of the waveforms is variable from 30V peak-to-peak (15V peak-to-peak into 50Ω) down to 1.5mV peak-to-peak. DC reference of the waveform can be offset positively or negatively. Maximum 150mA peak current can be continuously varied over an 80 dB range. A sync output provides a TTL level into 50Ω.

1.2 SPECIFICATIONS

1.2.1 Versatility

Waveforms
Selectable sine ∿ , triangle ∿ , square ⊓ , and dc with TTL sync. Symmetry of waveforms may be varied for sawtooth and variable duty cycle pulses.

Operational Modes
Continuous: Generator oscillates continuously at selected frequency.

Triggered: Generator is quiescent until triggered by external signal or manual trigger, then generates one cycle at selected frequency.

Gated: As triggered mode, except generator oscillates for the duration of gate signal plus time to complete the last cycle.

Frequency Range
0.002 Hz to 20 MHz in 9 overlapping decade ranges with approximately 1% of full scale vernier control.

Function Output
∿ , ∿ , ⊓ selectable and variable to 30 Vp-p (15 Vp-p into 50Ω). All waveforms and dc can supply 150 mA peak current and may be attenuated in 10 dB steps to 70 dB with 10 dB vernier for overall attenuation of 80 dB. 50Ω source impedance.

DC Output and DC Offset
Selectable thru function output BNC. Controlled by front panel control with separate on-off switch. Adjustable between ±15 Vdc (±7.5 Vdc into 50Ω) with signal peak plus offset limited to ±15 Vdc (±7.5 Vdc into 50Ω). DC offset and output waveform attenuated proportionately by the 0 to 70 dB output attenuator.

Sync Output
A TTL level pulse when terminated with 50Ω. Duty cycle varies with symmetry. 50Ω source impedance.

VCG—Voltage Controlled Generator
Up to 1000:1 frequency change with external 0 to ±5V signal. Upper frequency is limited to maximum of selected range.

Slew Rate: 2% of range per μs.

Linearity: ±0.5% thru ×1M range.
±5% on ×10M range.

Impedance: 5 kΩ.

Trigger (and Gate) Input

Input Range: 1 Vp-p to ±10V.

Trigger Level Adj: −5V to +5V.

Impedance: 10 kΩ, 33 pF.

Pulse Width: 25 ns min.

Repetition Rate:

Input	Max Rep Rate
±1V	1 MHz
±2.5V	10 MHz

Symmetry
Symmetry of all waveform outputs is continuously adjustable from 1:19 to 19:1. Varying symmetry provides variable duty-cycle pulses, sawtooth ramps and distorted sine waves.

NOTE

When SYMMETRY control is used, indicated frequency is divided by approximately 10.

1.2.2 Frequency Precision

Dial Accuracy
±3% of full scale from ×0.1 Hz to ×1 MHz.
±5% of full scale on ×10M range.

Time Symmetry
Square wave variation from 0.1 to 2 on dial less than:

±1% to 200 kHz.
±10% to 20 MHz.

1.2.3 Amplitude Precision

Amplitude Change with Frequency
Sine variation with frequency less than:
±0.2 dB on all ranges thru ×100K.
±0.5 dB on ×1M range.
±1.5 dB on ×10M range.

Step Attenuator Accuracy
±0.3 dB with 10, 20 and 40 dB attenuator setting.
±0.6 dB with 30, 50 and 60 dB attenuator setting.
±0.9 dB with 70 dB attenuator setting.

1.2.4 Waveform Characteristics

Sine Distortion
<0.5% on ×100, X1K, and X10K ranges.
<1.0% on ×0.1 to ×100 ranges.

All harmonics 30 dB below fundamental on ×100K, ×1M ranges, and 25 dB below fundamental on ×10M range.

Square Wave
Rise/Fall Time: <15 ns (10% to 90%).

Total Aberrations: ±5% of full amplitude.

Triangle Linearity
>99% for 0.002 Hz to 200 kHz.

1.2.5 General

Stability
Amplitude, frequency and dc offset after 30 minute warm-up.

Short Term: ±0.05% for 10 minutes.

Long Term: ±0.25% for 24 hours.

Environmental
Specification apply at 25°C ±5°C.

Instrument operates from 0°C to +50°C.

Dimensions
28.6 cm (11¼ in.) wide; 8.9 cm (3½ in.) high; 28.6 cm (11¼ in.) deep.

Weight
2.7 kg (6 lb) net; 4.5 kg (10 lb) shipping.

Power
100/120/220/240V (+5%, −10%), 48 Hz to 400 Hz, 70 VA.

NOTE

All specifications apply from 0.1 to 2.0 on frequency dial, when FUNC OUT is maximum and 50Ω terminated, and with SYM control OFF.

SYMMETRY and VERNIER controls affect frequency calibration. Maximum possible asymmetry is a function of frequency setting.

SECTION 2
INITIAL PREPARATION

2.1 MECHANICAL INSTALLATION

After unpacking the instrument, visually inspect all external parts for possible damage to connectors, surface areas, etc. If damage is discovered, file a claim with the carrier who transported the unit. The shipping container and packing material should be saved in case reshipment is required.

2.2 ELECTRICAL INSTALLATION

2.2.1 Power Connection

NOTE

Unless otherwise specified at the time of purchase, this instrument was shipped from the factory with the power transformer connected for operation on a 120 Vac line supply and with a ¾ amp fuse.

Conversion to other input voltages requires a change in rear panel fuse holder voltage card position and fuse (figure 2-1) according to the following procedure.

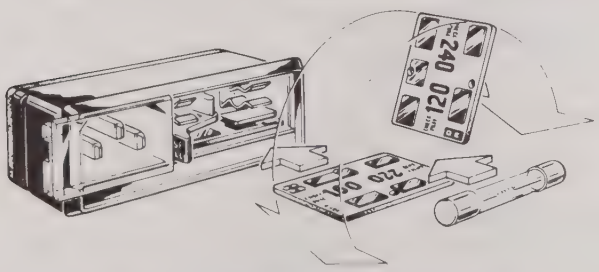


Figure 2-1. Voltage Selector and Fuse

1. Disconnect the power cord at the instrument, open fuse holder cover door and rotate fuse-pull to left to remove the fuse.
2. Remove the small printed circuit board and select operating voltage by orienting the printed circuit board to position the desired voltage to the top left side. Push the board firmly into its module slot.
3. Rotate the fuse-pull back into the normal position and insert the correct fuse into the fuse holder. Close the cover door.
4. Connect the ac line cord to the mating connector at the rear of the unit and the power source.

Card Position	Input Vac	Fuse
100	90 to 105	3/4 amp
120	108 to 126	3/4 amp
220	198 to 231	3/8 amp
240	216 to 252	3/8 amp

2.2.2 Signal Connections

Use RG58U 50Ω coaxial cables equipped with BNC connectors to distribute signals when connecting this instrument to associated equipment.

2.3 ELECTRICAL ACCEPTANCE CHECKOUT

This checkout procedure verifies the generator operation. If a malfunction is found, refer to the Warranty in the front of this manual. A dual trace, 150 MHz bandwidth oscilloscope with X10 time base magnification, a 50Ω load, a coaxial tee and three 50Ω cables are required to perform this checkout.

Set up as in figure 2-2 and preset the generator front panel controls as follows.

CONTROL	POSITION
Dial	1.0
FREQ MULT	1K
VERN/SYM	FREQ CAL (cw)
SYM	OFF (Extended)
MODE	CONT (FUNC)
TRIG LEVEL	10 o'clock
FUNCTION	∿
DC OFFSET (On/Off)	OFF (Extended)
DC OFFSET (Variable Control)	ccw
OUTPUT ATTEN 40, 20, 10	All Extended
AMPLITUDE	MAX (cw)
POWER	ON

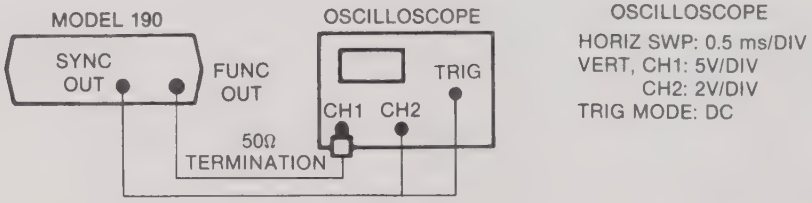


Figure 2-2. Checkout Setup

Table 2-1. Checkout Procedure

Step	Control	Position/Operation	Observation
1	Oscilloscope	Trig level and slope, both positive.	CH2: Square wave that begins on positive going edge. CH1: 15 Vp-p square wave.
2	Dial and VERNIER/SYM	Rotate dial full cw, vernier full ccw. Then the opposite. Return dial to 1.0, vernier to CAL.	CH2: Square wave remains in sync for all dial positions. Range is less than 2 Hz to 2000 Hz (1000:1).
3	FREQ MULT	Rotate to all positions. Return to 1K position.	Frequency is 1 × each range position.
4	AMPLITUDE	Set to 6 Vp-p on scope.	CH1: Amplitude decreases to approximately 6 Vp-p.

Table 2-1. Checkout Procedure (Continued)

Step	Control	Position/Operation	Observation
5	DC OFFSET	Depress DC OFFSET switch, then rotate DC OFFSET Control CW. (Extended DC OFFSET upon completion.)	Full CCW gives negative offset. Clipping occurs when the offset plus waveform peak amplitude exceeds approximately ±7.5V into 50Ω. Initially the negative peak is clipped, but as the DC offset is rotated cw the clipping of the negative peak disappears and eventually the positive peak begins to clip.
6	AMPLITUDE	Rotate cw.	Waveform returns to 15 Vp-p.
7	OUTPUT ATTN 10, 20, 40	Depress buttons in various combinations. Then release all buttons.	Output level varies from 15 Vp-p (0 dB) to 4.7 mV (70 dB).
8	FUNCTION	Rotate ccw. Select DC ∿ , ⩘ , ⊓ . Reset to ∿ .	Observe 0 Vdc level; ∿ , ⩘ and ⊓ are 15 Vp-p. Note phase relationships; ⊓ in phase with ∿ and ⩘ .
9	SYM, VERNIER/SYM.	Depress SYM switch and rotate VERNIER/SYM control ccw. Extend SYM, return VERNIER/SYM to CAL.	Frequency decreases to approximately 1 kHz. CCW of the 12 o'clock position gives 1:19; CW gives 19:1 (a skewed sinewave and variable duty cycle pulses can be observed for ∿ and ⊓ .)
10	MODE and FUNCTION	Select GATE. Select ∿ , ⩘ , ⊓ . Return to ∿ .	A dc level near zero volts (except ⊓ function; quiescent level is at negative peak value).
11	MANUAL TRIGGER	Press, hold and release.	A burst of ⩘ for the period the MAN TRIG is depressed.

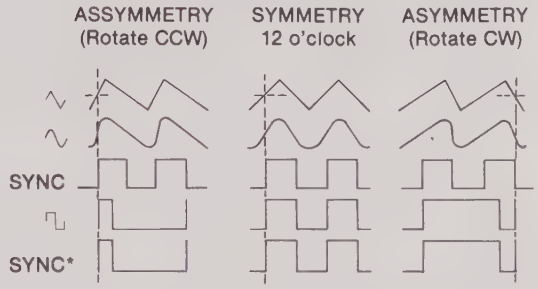
3.1 CONTROLS AND CONNECTORS

The generator front panel controls and connectors are shown in figure 3-1 and keyed to the following descriptions.

1 **Frequency Dial** — Settings under the dial index mark summed with **13** and multiplied by **2** determine the output signal frequency.

2 **FREQ MULT Control** — Selects one of nine frequency multipliers for dial **1** setting.

VERNIER/SYM Control — When the SYM switch **3** is off (extended) this inner control is a fine adjustment of the frequency dial **1** setting. When the SYM switch is on (depressed) this control varies the symmetry of the waveforms (normally 50% duty cycle). Symmetry range is 19:1 to 1:19 (half cycle to half cycle ratio). When SYM is used, the main generator frequency is divided by 10. Extending SYM switch ensures 1:1 (50%) symmetry. See figure 3-2.



* SYNC DUTY CYCLE VARIES SAME AS FUNC OUT SIGNAL WHEN SQUARE FUNCTION (⊓⊔) IS SELECTED.

Figure 3-2. Effect of Symmetry Control

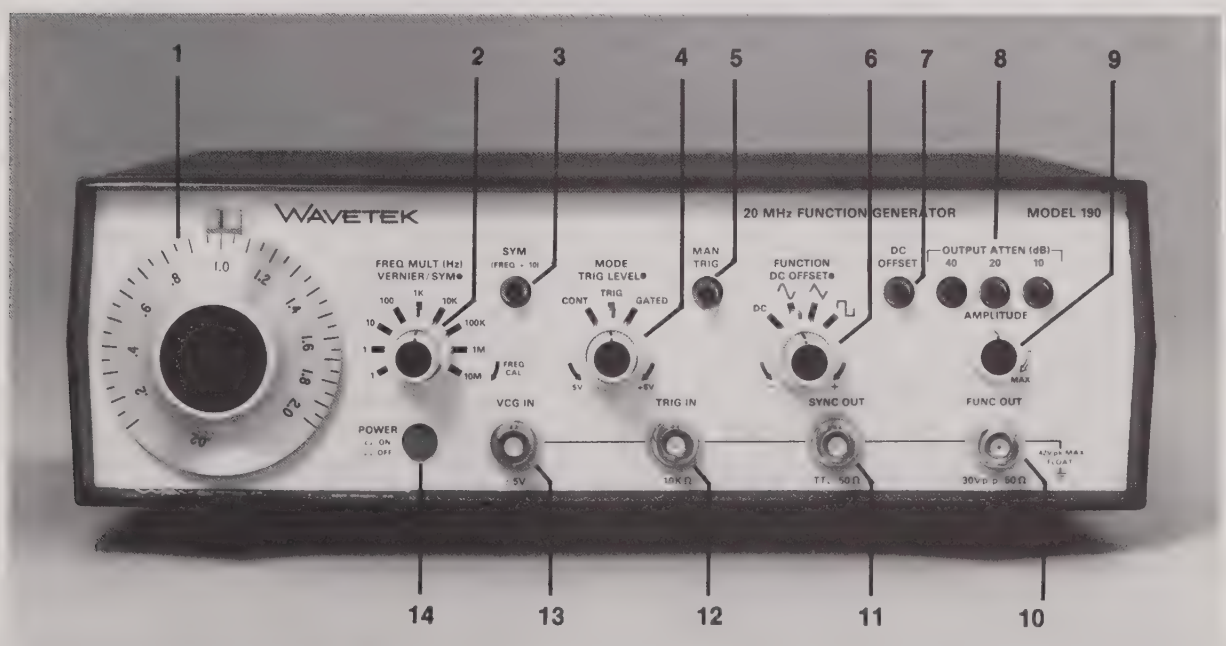


Figure 3-1. Controls and Connectors

3 SYM Pushbutton — This switch, when depressed, allows the waveform symmetry to be varied 19:1 to 1:19 range by the VERNIER/SYM control **2**; as a result the generator frequency is divided by 10. When extended, the switch allows the generator to produce normal (50% duty cycle) waveforms.

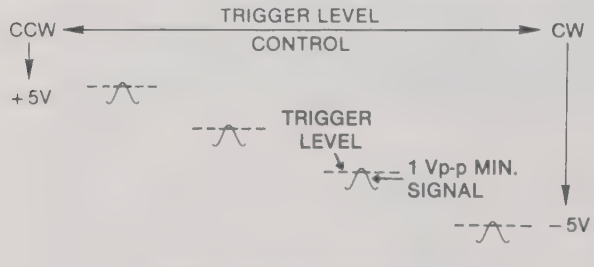
4 MODE Control — This switch selects one of the three operating modes:

CONT — Continuous output at FUNC OUT **10** and SYNC OUT **11** connectors.

TRIG — A dc level output until the generator is triggered by the MAN TRIG **5** or with a signal at the TRIG IN connector **12**. When triggered the generator output is one cycle of waveform followed by a dc level.

GATED — As for TRIG except the output is continuous for the duration of the manual or external trigger signal. The last waveform cycle started is always completed.

TRIG LEVEL Control — This inner control is a continuously variable adjustment of the trigger circuitry firing point. When full ccw, a positive going signal at approximately +5V is required for triggering (see figure 3-3). In the full cw position, a positive going signal at approximately −5V or more positive voltage is required for triggering. In the GATED modes, the generator will run continuously when the control is cw from 12 o'clock.



Trigger signal must be a positive going signal exceeding the TRIGGER LEVEL setting.

Figure 3-3. Minimum Trigger Signal

5 MAN TRIG Pushbutton — Triggers or gates the output signals when generator mode is TRIG or GATED **4**. In trigger mode, one waveform cycle is output when the button is pushed. In gated mode, waveform cycles are continuously output as long as the button is held in.

6 FUNCTION Selector — Outer coaxial knob selects one of three waveforms (sine, triangle, square) or dc.

DC OFFSET Control — Inner coaxial control offsets the main generator output waveform vertically from its normal position and when FUNCTION (outer coaxial switch **6**) is in the DC position, controls polarity and voltage of dc output. DC output range is 0 ±15 Vdc (±7.5 Vdc into 50Ω). DC OFFSET switch **7** must be depressed to enable this DC OFFSET Control. Extending the DC OFFSET switch ensures zero volt offset. DC offset and waveform are attenuated by the OUTPUT ATTEN control **8**, but dc offset is not attenuated by the AMPLITUDE control **9**. Waveform peak voltage plus dc offset is limited to ±15 Vdc (±7.5 Vdc into 50Ω). See figure 3-4.

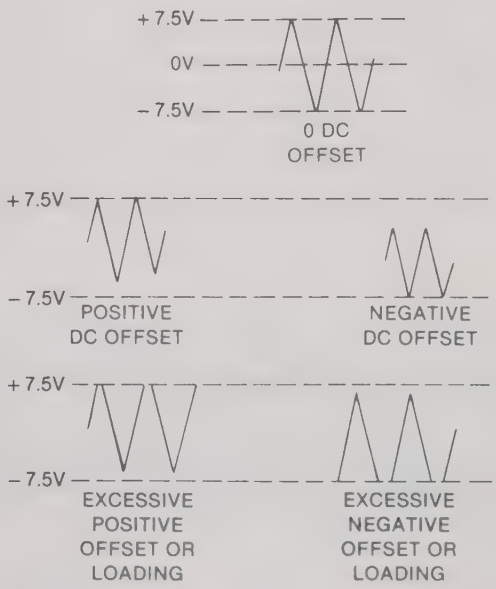


Figure 3-4. DC OFFSET Control

7 DC OFFSET Pushbutton — When depressed, the dc offset is switched on and controlled by the DC OFFSET control **6**. When extended, zero offset is assured.

8 OUTPUT ATTEN Pushbuttons — These buttons select the attenuation range of the FUNC OUT **10** signal. The AMPLITUDE control **9** allows continuous level variations within each attenuator range. Each of the three buttons may be used individually for 40, 20 or 10 dB steps of attenuation, or pressed in combinations for up to

70 dB of attenuation. The attenuator attenuates both the waveform and dc offset.

9 **AMPLITUDE** — This control continuously varies the waveform amplitude within each OUTPUT ATTEN **8** range. CCW rotation reduces waveform amplitudes at FUNC OUT **10** by approximately 10 dB. DC and dc offset voltages are not affected by this control.

10 **FUNC OUT Connector** — This BNC is the waveform (or dc) output of the generator. Maximum output is 30 Vp-p (15 Vp-p into 50Ω). Source impedance is 50Ω.

11 **SYNC OUT Connector** — The sync signal from this BNC is a TTL level into 50Ω. Duty cycle varies with waveform symmetry. Source impedance is 50Ω.

12 **TRIG IN Connector** — This BNC receives the external trigger and gate signals. These signals are applied to the trigger and gate circuit when the MODE switch **4** is in the TRIG or GATED positions. Refer to paragraph 1.2.1, Trigger (and Gate) Input, for trigger signal requirements. The TRIG LEVEL control **4** selectively accepts trigger and gate signals for the trigger and gate circuits.

13 **VCG IN Connector** — This BNC accepts ac or dc voltages to proportionately control frequency within the range determined by the FREQ MULT **2**. Positive voltages increase the frequency set by the dial **1**; negative voltages decrease the frequency. The VCG IN will not drive the generator frequency beyond the normal limits of a range. Input impedance is 5 kΩ.

14 **POWER Pushbutton** — Depressed is power on, extended is power off.

3.2 OPERATION

Perform the initial checkout in Section 2 for the feel of the instrument. Any questions concerning individual controls and connectors may be answered in paragraph 3.1.

3.2.1 Signal Termination

Proper signal termination, or loading, of the generator connectors is necessary for its specified operation. For example, the proper termination of the 50Ω OUT connector is shown in figure 3-5. Placing the 50 ohm terminator, or 50 ohm resistance, in parallel with a higher impedance, matches the receiving instrument input impedance to the coax characteristic and generator output impedance, thereby minimizing signal reflection or power loss on the line due to impedance mismatch.

The input and output impedances of the generator connectors are listed below.

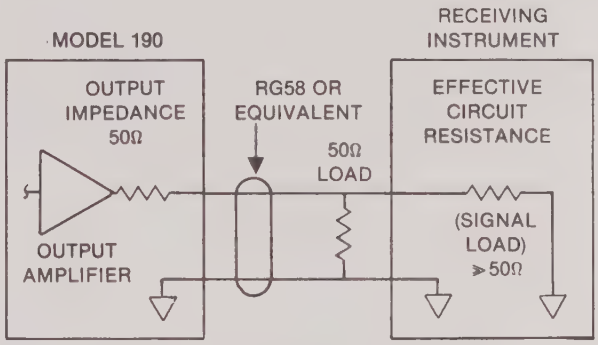


Figure 3-5. Signal Termination

Connector	Impedance
FUNC OUT	50Ω
SYNC OUT (TTL)	50Ω
TRIG IN	10k
VCG IN	5kΩ

3.2.2 Manual Function Generator Operation

The following steps demonstrate manual control of the function generator. (Bold numbers are keys to figure 3-1.)

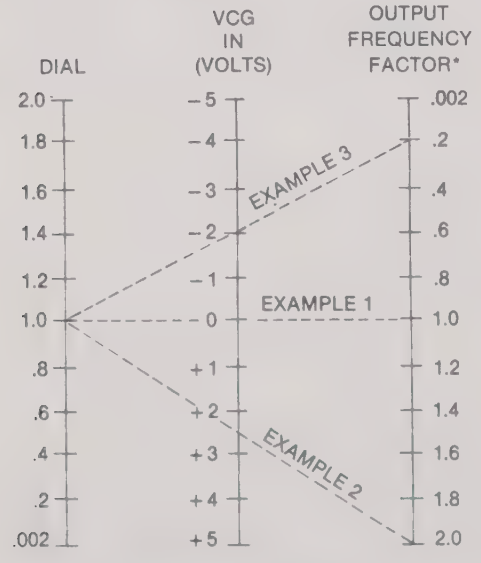
Step	Control/Connector		Setting
1	FUNC OUT	**10**	Connect circuit to output (refer to paragraph 3.2.1).
2	MODE	**4**	Select CONT.
3	SYM	**3**	Extended.
4	FREQ MULT	**2**	Set to desired range of frequency.
5	Frequency Dial	**1**	Set to desired frequency within the range.
6	FUNCTION	**6**	Set to desired waveform.
7	DC OFFSET	**7**	Set as desired. Limit offset to prevent waveform clipping (see figure 3-4).
8	OUTPUT ATTEN	**8**	Select for desired attenuator range.
9	AMPLITUDE	**9**	Select for desired waveform amplitude.

3.2.3 Voltage Controlled Function Generator Operation

Operation as a voltage controlled function generator (VCG) is as for a manually controlled function generator, only the frequency within particular ranges is additionally controlled by an external voltage (±5V excursions) injected at the VCG IN connector. Perform the steps given in paragraph 3.2.2, only set the frequency dial to determine a reference from which the frequency is to be voltage controlled.

1. For frequency control with positive dc inputs at VCG IN, set the dial for a lower frequency limit.
2. For frequency control with negative dc inputs at VCG IN, set the dial for an upper frequency limit.
3. For modulation with an ac input at VCG IN, set the dial at the desired center frequency. Do not exceed the maximum dial range of the selected frequency range.

Figure 3-6 is a nomograph with examples of dial and voltage effects. Example 1 shows that with 0V VCG input, frequency is determined by the main dial setting, 1.0 in this example. Example 2 shows that with a positive VCG input, output frequency is increased. Example 3 shows that with a negative VCG input, output frequency is decreased. (Note that the Output Frequency Factor column value must be multiplied by a frequency range multiplier to give the actual output frequency.)



*Must be multiplied by FREQ MULT switch setting

Figure 3-6. VCG Voltage-to-Frequency Nomograph

NOTE

Nonlinear operation may result when the VCG input voltage is excessive; that is, when the attempted generator frequency exceeds the range limits. The upper limit is 2 times the multiplier setting, and the lower limit is 1/1000th of the upper limit.

The up to 1000:1 VCG sweep of the generator frequencies available in each range results from a 5V excursion at the VCG IN connector. With the frequency dial set to 2.0, excursions between −5V and 0V at VCG IN provide the up to 1000:1 sweep within the set frequency range.

3.2.4 Waveforms

See figure 3-7 for definition of controllable waveform characteristics.

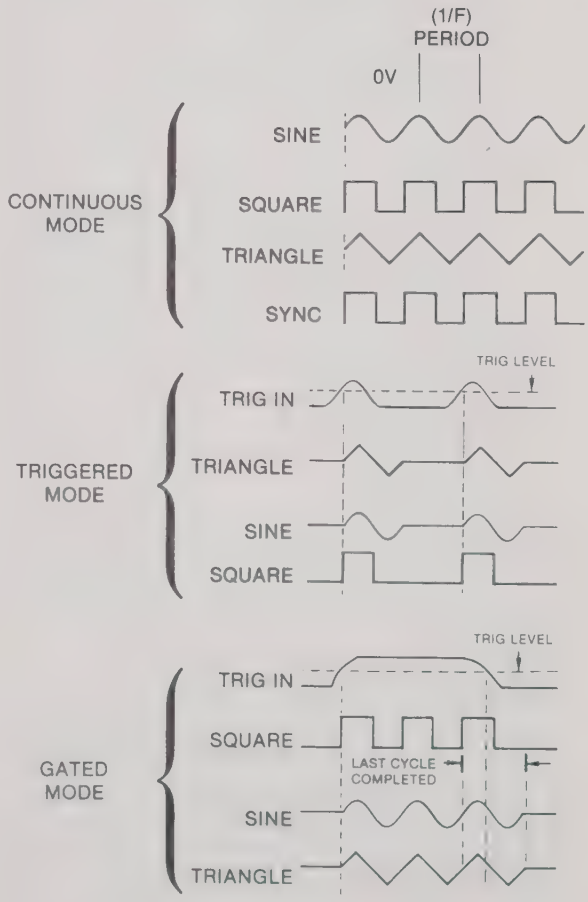


Figure 3-7. Waveform Characteristics

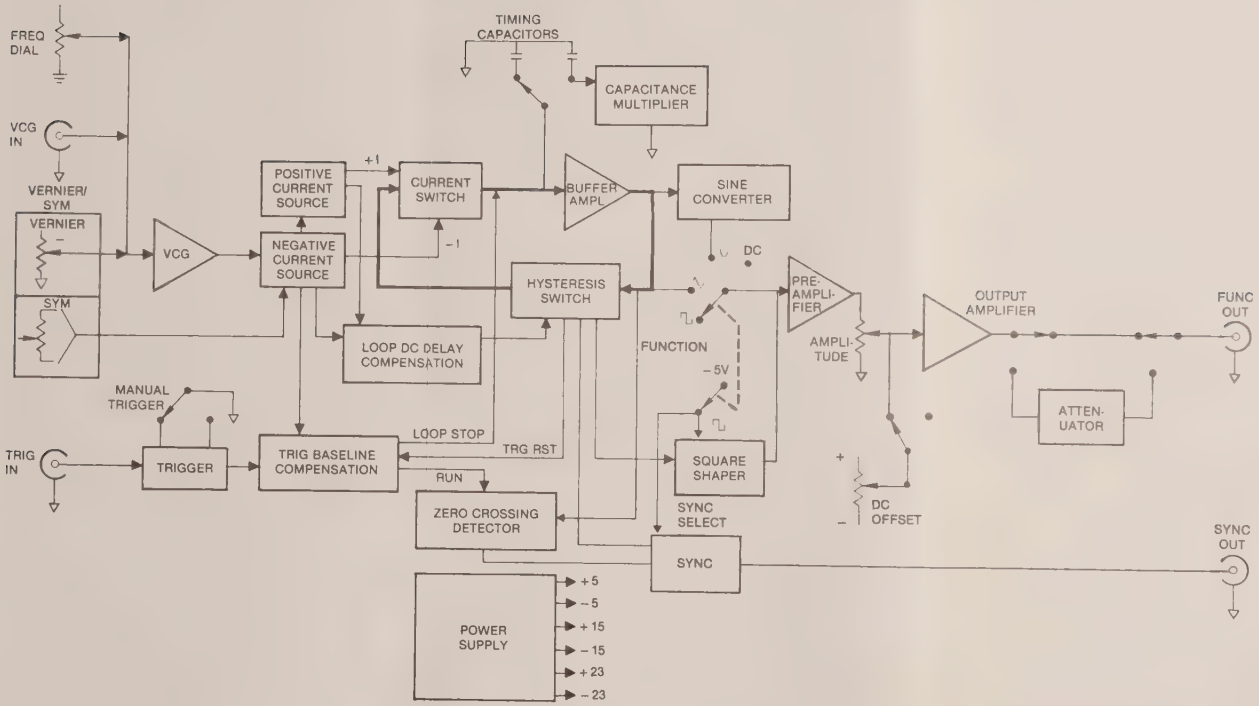


Figure 4-1. Function Block Diagram

SECTION 4
CIRCUIT DESCRIPTION

4.1 INTRODUCTION

This section describes the functions of the major circuits elements and their relationships to one another as shown in figure 4-1, functional block diagram.

4.2 FUNCTIONAL BLOCK DIAGRAM ANALYSIS

As shown in figure 4-1, the VCG (Voltage Controlled Generator) sums the voltage inputs from the frequency dial, VCG IN, and frequency vernier to provide a voltage control signal for the positive and negative current sources. The positive and negative current sources generate precision currents, linearly related to the output of the VCG summing amplifier, which pass through the current switch to the timing capacitors. Additional linear currents are generated for loop dc delay compensation and the trigger baseline compensation.

The current switch, controlled by the hysteresis output, causes either the positive current source or the negative current source to charge the timing capacitor selected by the frequency multiplier. When the positive current source is switched in, the charge on the timing capacitor will rise linearly producing the positive-going triangle slope. Likewise the negative current source produces the negative going triangle slope.

The triangle buffer amplifier is a unity gain amplifier whose output is fed to the hysteresis switch, sine converter and output circuits. The hysteresis switch operates as a "window" comparator with limit points set to the triangle peaks. When the positive going ramp reaches +1.0V, the hysteresis switch toggles to a low state causing the current switch to connect the negative current source. This causes the timing capacitor voltage to linearly ramp to −1.0V as the timing capacitor voltage reaches −1.0V, the hysteresis switch toggles to a low state, switching in the positive current source. The generator loop continues to oscillate producing simultaneous triangle and square waves, at a frequency determined by the frequency multiplier and the magnitude of the timing current controlled by the sum of the dial setting, the VCG input, and the vernier.

Depressing the SYM button produces an unsymmetrical waveform and a division of the frequency by a factory of 10. The VERNIER/SYM control creates an imbalance in the current sources and therefore an imbalance in the waveform symmetry up to a ratio of 19:1. The result is variable duty cycle pulse, variable askewed sine wave and variable "sawtooth" triangle waves.

The dc loop delay compensation circuit is used on the two highest frequency ranges to compensate for loop delay. This circuit causes the hysteresis switch trip points to switch earlier in the cycle, and prevents the timing capacitors from charging beyond ±1.0V. The switch points are adjusted in proportion to the charging current, thus ensuring a constant amplitude as frequency is varied.

The capacitance multiplier is an active circuit which simulates capacitors up to 10,000 times larger than the timing capacitor, thus allowing very long charging times using physically small capacitors. This circuit is used in the four lowest frequency ranges.

The sine converter accepts a ±1.0 volt triangle signal from the triangle buffer and converts it to a sine wave current. The output is fed via the function switch to the preamplifier.

The trigger circuit allows precise single or multiple (gated) cycles at the output in response to external trigger signals or manual trigger operation. The trigger circuit operates by holding the timing capacitor at 0 volts, via the loop stop signal, on the positive going triangle ramp, until a trigger signal occurs. In the TRIG mode a single cycle is produced for each trigger signal above the variable trigger level threshold. In the GATED mode continuous cycles are generated for the time period at which the external signal is above the trigger level threshold plus the time for completion of the last partial cycle. The RUN signal causes the SYNC output to stay in the low state when the generator is quiescent. The TRGRST signal resets the trigger circuit and generator to the quiescent state on every generator cycle to arm it for the next trigger input. The trigger baseline compensation circuit holds the generator output at zero volts, LOOP STOP, (within specified limits) during the quiescent intervals at any position (value) of the frequency dial, FREQ MULT, VCG IN, or VERNIER.

The sync circuit accepts the square wave signal from the hysteresis or the zero crossing detector switch and converts it to a true 50Ω TTL level output. In square wave function (SYNC SELECT enabled) the sync is in phase with the output, but in triangle or sine functions (SYNC SELECT disabled), the zero crossing detector causes the sync output to be in phase with the zero crossing of the output waveform.

When square is selected by the function switch, the square shaper accepts the signal from the hysteresis switch and converts it to a clean, fast square wave current to drive the preamplifier. The function switch also enables the sync circuit, causing the sync output to be in phase with the positive going edge of the output square wave. In sine, triangle or DC functions, the square shaper input and output are disabled so as not to interfere with the selected waveform.

The preamplifier is fed from both the function switch and the square shaper. The voltage output drives the output amplifier via the amplitude control.

The output amplifier accepts signals from the preamplifier by way of the amplitude control and drives the output attenuator. DC offset is achieved by offsetting the output amplifier.

The output attenuator, fed directly from the output amplifier, provides up to 70 dB of attenuation to the selected waveform or DC offset. This signal is connected directly to the FUNC OUT BNC.

4.3 DETAILED CIRCUIT DESCRIPTION

4.3.1 Current Sources

Refer to the Generator Board Schematic sheet 4. The VCG IN (J7) and FREQ VERNIER (R88) are summed with the dial potentiometer (R56) at the summing node, U14 pin 6 of the VCG amplifier. Full scale on the dial causes a −5 volt control signal at the dial buffer output U14 pin 7. Rotating the dial to minimum, plus turning the FREQ VERNIER ccw produces −5 mV at U14 pin 7. The output of the buffer drives both the GCV buffer and current sources. The GCV output at U14 pin 1 is +5.0 volts at full scale.

The current source from U14 pin 7 is present at U13 pin 1. The output of U13 at pin 12 is fed through level shifting transistor Q14 to U8 pin 6. The collector current at pin 7 flows from ground through R81 and R80. As the voltage at U14 pin 7 varies, amplifier U13 and transistor Q14 adjust the base drive of U8 pin 6, and hence the collector current, until the voltage at U13 pin 2 equals the voltage at U13 pin 1. Because U8 is an array of matched transistors with the bases connected together, and all emitter resistors are equal with VERNIER selected, all collector currents are also equal.

The positive current source is controlled by a current control signal at U8 pin 1, which is held at 0 volts by the servo action of U13 pins 6, 7 and 10, level shifting transistor Q15 and U7 pins 6 and 7. The current "I" in R84 must flow through R93, and because these resistors are both 1kΩ, an equal but opposite base control voltage is present on U7 pin 6 compared to U8 pin 6. Because the transitors in U7 are matched and their bases are at the same point, a positive current "I" flows in R97 and hence the positive current source. A small amount of adjustable balance is provided by R95 and R94 to enable the positive and negative currents to be set for correct symmetry.

On the 1M and 10M ranges, the timing current is increased by approximately 25%, allowing the use of larger timing capacitors and hence, minimizing the effect of any stray capacitance. On the higher ranges, the parallel resistance across R83 (at ISCAL) is greater than the resistance on the lower ranges. This would decrease the current through U8 pin 8 were it not for the servo loop action of U13 pin 12, Q14 and U8 pins 6, 7 and 8. For any VCG setting at U14 pin 7 and U13 pin 1, no matter which range is selected, this servo loop maintains the voltage at U13 pin 2 equal to pin 1. Because the voltage at U13 pin 2 remains constant from range to range, the voltage across, and therefore the current through R80 and R81 also remains constant. This current also flows through U8 pins 7 and 8. To enable this current to remain constant, the servo loop drives the base voltage at U8 pin 6 in a positive direction. Because all of the bases in U8 are at the same point, the current relative to the lower ranges increases in R84 through R87 and also in the collectors of U8 pins 1, 14, 2, and 9.

Variable symmetry is controlled by R88 which doubles as the frequency vernier. With VERNIER selected, R88 functions as a frequency vernier with one end of the control connected to ground and the other connected to the −15 volt supply. The wiper supplies current to the summing node U14 pin 6. Additionally, one end of 1kΩ resistors R84 through R87 are all connected to the −15 volt supply. For any given dial setting, the current through each of the four resistors is "I". With SYM selected, R88 functions as a variable symmetry vernier with the wiper connected to the −15 volt supply. One end of this vernier supplies current to R84 and R85, while the other end supplies current to R86 and R87. With the vernier centered, each leg is approximately 5000Ω and reduces the current through each of these 4 resistors to 1/10 I, dividing the generator frequency by 10. As the symmetry control

is varied, resistors for the positive and negative current sources are changed in ratio, hence the current sources are unbalanced and the timing for the positive waveform is varied in respect to the negative waveform, resulting in variable symmetry.

Loop delay dc compensation currents (+ICMP and −ICMP), are supplied by Q16 and U8 pin 9 and track the timing currents.

A current (ITRGBL), is supplied by U8 pin 14 to the trig baseline circuit to compensate for variations in freq dial settings when the generator is in a quiescent trigger or gated mode.

4.3.2 Current Switch

Refer to sheet 3. The current switch is driven by the square wave signal (ISWCTRL) from the hysteresis switch. Level shifting transistor Q10 provides a control signal for the diode bridge CR8, CR9, CR30 and CR31. When the control signal is +1.8 volts, CR30 is reversed biased, allowing CR8 to conduct current from the positive current source to the timing capacitor selected by SW9-D. This produces a positive going ramp. CR31 is also turned on, which reverse biases CR9 and prevents current sinking from the timing capacitor to the negative current source. When the control signal is −1.8 volts, both CR30 and CR9 are forward biased, while CR31 and CR8 are reversed biased. At this time, current from the negative current source sinks from the timing capacitor, producing a negative going ramp.

4.3.3 Triangle Buffer Amplifier

Refer again to sheet 3 of the schematic. The signal on the selected timing capacitor is present at both the gate of Q11, and at U9 pin 2. These devices provide a very high input impedance for the signal to avoid leakage which would otherwise cause poor triangle linearity. The output current of Q11 controls the base drive to emitter follower Q13 and hence the output voltage on the emitter. This voltage is sensed at U9 pin 3, causing U9 to adjust the base voltage of Q12 until the differential input of U9 is zero. The low impedance source output voltage at the emitter follower Q13 now follows the high impedance input signal at the gate of Q11 with a circuit gain of 1.0 up to a bandwidth of approximately 1 MHz, above which the gain will drop down to approximately 0.95 typically.

4.3.4 Hysteresis Switch

Refer to sheet 2. U10 pin 5 is the input to the positive peak comparator, while pin 10 is the input to the negative peak comparator. A level shifted triangle signal of −0.9 volts to −2.8 volts is present at pins 5 and 10 of U10. Assume a positive going ramp. R18 and R19 set the reference voltage on U10 pin 4 at −0.9 volts. When the voltage on pin 5 exceeds the reference voltage on pin 4, the positive comparator changes state and the voltage on pin 3 pulses from an ECL low (−1.8V) to an ECL high (−0.8V). This signal is connected to clear direct (pin 4) of D flip flop U5. The output of U5 pin 2 goes low, while U5 pin 3 goes high. These outputs toggle the differential pair Q7 and Q8 so that Q7 is on and Q8 is off. This causes the current switch control signal (ISWCTRL) to go low, which connects the negative current source to the timing capacitor, and causes the triangle to begin to ramp negative. The negative peak comparator functions in an identical manner to the positive comparator except that the reference voltage at U10 pin 9 is −2.8 volts. At the negative triangle peak, U10 pin 6 pulses high, causing a set direct at U5 pin 5, toggling the current switch signal (ISWCTRL) high and producing a positive going ramp. In addition to being used to store the first peak comparison pulse from U10 pins 3 and 6, U5 also ignores "chatter" from both positive and negative comparators.

4.3.5 Loop DC Delay Compensation

The circuit is also located on sheet 2 of the schematic diagram. The purpose of this circuit is to adjust the reference voltages on the comparators in the two highest frequency ranges so that the triangle peaks do not increase in amplitude due to loop delay. Q2 functions as a variable positive current source controlled by the range switch and the main current source. As the generator frequency is increased, the base voltage of Q2 progressively moves negative causing positive current through R15 and increasing the reference voltage on U5 pin 9 in a positive direction. This causes the negative peak to switch earlier in time, compensating for the loop delay and maintaining constant triangle amplitude and correct frequency tracking.

The positive peak comparator reference is changed in an identical way, except that the voltage on U10 pin 4 becomes more negative with increased frequency. Q4 is a variable negative current source. Q1 and Q3 function as temperature compensating diodes.

4.3.6 Capacitance Multiplier

Refer to schematic diagram sheet 5. The capacitance multiplier is a precision current splitter which shunts up to 99.990% of the VCG current away from the integrating capacitor (C57) to produce the 100 through 0.1 frequency ranges. Timing current is divided between

C57 and R114, then again between R113 and the selected timing resistor (R110 through R112 or R108).

The signal at U11 pins 2, 6, and 7 is a ±1.0 volt triangle. U11 (pins 6, 7, and 10) is a non-inverting amplifier with a gain of 8. The waveform at U11 pin 1 is a ±1.0 volt triangle with 0.5 volt spikes at each peak. At any given moment, the junction of R103 and C55 (differentiator circuit input) has 8 times the voltage as the junction of R104 and C55. This voltage difference causes a constant current to charge C55 through R104 and the selected timing resistor. Thus a frequency dependent charging current flows into the summing node of U11 pin 1, producing an inverted square wave component at the differentiator output U11 pin 12 sinking or sourcing current from the main current sources and limiting the amount of current available to charge C57. The ±1.0 triangle at U11 pin 2 provides the triangle portion of the waveform at U11 pin 12. Since the triangle slopes on U11 pins 1 and 12 are identical, only the square wave component of the waveform at U11 pin 12 is across the timing resistor. The amount of current supplied to charge C55 is therefore this voltage divided by the range resistor value. As the range resistor is increased, the feedback for U11 between pins 1 and 12 is also increased, causing less current to charge C55 and increasing the amount of current being shunted to U11 pin 12 by a factor of 10 for each lower frequency range.

4.3.7 Sine Converter

Refer to sheet 6 of the circuit diagram. The sine converter converts the buffered ±1.0 volt peak triangle to a sinusoidal current of 2mA peak. The input triangle voltage (TRIBUFC) passes through a voltage divider network to the input of the diode at pins 1, 4 and 6. As this signal progressively increases, the diode between pins 1 and 9 is progressively reversed biased, sinking less current and causing the diode between pins 2 and 5 to pass increasingly more current in a sinusoidal manner to IFUNC. This produces the positive half of the sine wave at the output of the preamplifier. At the same time, the diode between pins 2 and 8 is progressively reversed biased. This slows and eventually prevents current from flowing from the negative portion of the sine converter.

When the input waveform moves negatively, the diode between pins 2 and 5 is reversed biased and the diode between pins 2 and 8 progressively conducts, producing the negative half of the sine wave.

R159 sets the input amplitude for correct biasing of the sine conversion diodes, while R165 adjusts the input signal offset. Thermister R161 adjusts the input voltage to compensate for the diode voltage change with temperature. The network consisting of R166, R167 and C102 provides a signal (SINCMP) to the non-inverting input of the preamplifier to compensate for the effects of diode capacitance which would otherwise distort the sinewave peaks at high frequencies.

4.3.8 Trigger Circuit

Refer to sheet 5. The trigger input at J8 is added to the voltage from the trigger level control R119 and compared at U12 pin 5 with a reference at U12 pin 4. When the signal at U12 pin 5 exceeds pin 4 by a few millivolts, U12 pin 3 goes high. R120 and C60 ensure a noise free pulse at U12 pin 3 which is one of two wire ORed inputs to U4 pin 7. The second input originates from the MAN TRIG switch circuit. When this switch is depressed, R115 pulls U12 pin 10 low. Pin 10 is compared to the Vbb reference voltage at pin 9, latching pin 6 high and preventing false triggering due to switch contact bounce. Pin 13 connected to pin 6, is referenced to pin 12, causing pin 15 to also go high. When either U12 pin 3 or pin 15 go high, U4 pin 3 goes low because these outputs are wire ORed to U4 pin 7. U4 pin 3 is connected to pins 4 and 10. Because pin 10 was previously high, U4 pin 14 was low causing a low at U4 pin 5. The trigger pulse low at U4 pin 4 causes a 10 ns ECL high pulse at U4 pin 2. At the same time, U4 pin 14 goes high and after the time delay set by R126 and C62, U4 pin 5 also goes high. This causes U4 pin 2 to return low.

In the gate mode CR14 holds U4 pin 11 high, forcing pin 14 low. The length of the control pulse at U4 pin 2 is now equal to the period during which U4 pin 7 is held high. In the continuous mode, U4 pin 2 is held high by CR16 regardless of any input trigger signals.

4.3.9 Trigger Baseline

Refer to sheet 5. In the trigger mode, with no trigger inputs, U5 pin 12 is held low. On the next positive going triangle, the trigger reset (TRIG RST) signal at U5 pin 11 causes U5 pin 14 to go high. This turns Q18 off and Q17 on, which turns off Q19. The Q19 emitter voltage is pulled down by the negative current sources Q20 and Q21, causing CR19 to conduct. Because the anode is at ground and CR18 is matched to CR19, the voltage at the anode of CR18 is also zero. This causes the triangle on the positive going ramp to stop at exactly zero volts. When a trigger signal occurs, U5 pin 12 goes high for about 10ns, causing pin 15 to also go high. This turns on Q18 and turns off Q17, which turns on Q19, causing the emitter to rise to about 1.7 volts. This reverse biases CR18 and CR19 causing the generator to run for exactly one cycle. In the gate mode, U5 pin 12 is held high for the duration of the in-

put signal causing the generator to run for this interval plus the time required to complete a partial cycle.

In the trigger or gated mode, quiescent state, positive charging current I flows in CR18. As the VCG current is varied, I also varies, causing the voltage across CR18 to vary. To prevent this from causing a baseline shift, current (I) must also flow in the reference diode CR19. A negative current source (ITRGBL) is connected to the bases of Q20 and Q21. Negative current ($-I$) flows through the collector of Q20 and R133. Because of the configuration of Q20 and Q21, and because R133 and R134 are both 1kΩ, an equal amount of current $-I$ also flows through the collector of Q21 and R134, causing $-2I$ to flow at the junction of R133 and R134. Half of this current ($-I$) flows through CR19, while the remaining current flows through CR18. Therefore, the anode of CR18 is held at zero volts regardless of the VCG summing node current.

The RUN signal is used to hold the sync output low during quiescent periods.

4.3.10 Sync

Refer to sheet 2. The SYNC OUT amplifier is driven from the signal at U6 pin 10 in the triangle and sine functions, and from U6 pin 7 when the function switch is in the square function. These two inputs are wire ORed at U6 pin 13.

In the triangle and sine functions, SYNC SEL allows R23 to pull CR4 high causing a low at U6 pin 2. This enables the signal from the zero crossing detector output (U10 pin 15), and disables the hysteresis switch input at U6 pin 7. When the positive going ramp crosses 0 volts at the zero crossing detector input U10 pin 13, U10 pin 15 and U6 pin 10 go high. This causes a low at U6 pins 14 and 13. U6 pin 9 goes low and pin 15 goes high turning on Q5 and turning off Q6. This results in a high at SYNC OUT. As the triangle at U10 pin 13 crosses 0 volts in a negative direction, pin 15 goes low, causing Q5 to be turned on, producing a low at SYNC OUT. Therefore the SYNC OUT always toggles when the triangle crosses 0 volts.

When the square wave function is selected, CR4 pulls U6 pins 4 and 6 low. U6 pins 2 and 11 now go high, disabling the zero crossing detector input from pin 10, and enabling the square wave input from U6 pin 7. U5 pin 3 now drives the SYNC OUT connector in a similar manner as U10 pin 15. The SYNC OUT is in phase with the square wave output.

R26, a 49.9Ω resistor sets the 50Ω output impedance.

4.3.11 Square Shaper

The square shaper schematic is located on sheet 6. In square function, CR20 pulls U4 pin 13 low, enabling the hysteresis switch input (HYS) at U4 pin 12. A low at U4 pin 12 causes a low at U4 pin 15 and a high at pin 9. Q22 turns on while Q23 is turned off, producing a $+1.2$ volt high at the bases of the current switch control transistors Q24 and Q25. Transistor Q25 is on, reverse biasing CR23. Transistor Q24 is off allowing positive current to flow through R147, CR22, R154 and into the preamplifier node via R152.

When HYS toggles high, Q23 turns on forcing the bases of Q24 and Q25 to -1.2 volts. Q24 turns on and Q25 turns off, allowing negative current to flow through R157, CR23, R154 and the the amplifier node via R152.

R152 and R154 form a current divider to obtain a 2mA full scale current into the preamplifier. Overshoot caused by diode capacitance is reduced by R153 and C73. The output of the square shaper is disabled in all other functions by turning on Q26 and CR24 which reverse bias CR22 and CR23 and prevents current from flowing through R152.

4.3.12 Preamplifier

Refer to sheet 7 of the schematic circuitry. For all functions, full scale output voltage is produced when 2mA is injected into the input summing node U1 pin 8. Transistor array U1 forms a cascaded differential stage. Transistor Q27 is a fixed current source. Q28 and Q29 form a high gain voltage follower. DC negative feedback is applied through R195 to U1 pin 8. The closed loop voltage gain of the amplifier is determined by the ratio of R195 to the input resistors, R152 for square wave and R176 for triangle. The sine converter output supplies the correct current directly from U3 pin 2 to U1 pin 8. The servo action of the preamplifier holds this point at 0 volts, therefore no voltage can be measured. U1 pin 4 is the non-inverting input and is used both to adjust the offset to 0 volts at TP2 using R185 and to inject the sine converter compensation signal (SINCMP) described under paragraph 4.3.7, Sine Converter. High frequency compensation is provided by R182, C81, C86 and C153. Zener diode CR29 provides increased collector voltages for U1 pins 11 and 12 and also allows these two points to be relatively close in voltage.

4.3.13 Output Amplifier

The output amplifier consists of an ac coupled amplifier for signals above about 16 kHz, and a dc coupled

amplifier for signals below about 16 kHz, and to maintain zero dc output offset within specified limits. Refer to the simplified output amplifier schematic, figure 4-2.

Assume zero input voltage at the junction of R203 and R218. The output at R222 and R224 is maintained at 0 volts by dc amplifier U2. U2 pin 3 is connected to a 0 volt reference. If the output drifts away from 0 volts, this will be sensed at U2 pin 2 through R256, R257 and R254. Amplifier U2 will sense a difference between its inputs and produce an output voltage which adjusts the bias in the ac coupled amplifier to return the output to 0 volts. Because R218 and R223 form half of a balanced bridge, and R253, R256 and R257 form the second half, the amplifier node at the junction of R218 and R223 will be held at 0 volts as U2 has returned the junction of R253 and R256 to 0 volts.

A dc input of +1 volt at R218 and R253 is sensed as a positive increase at U2 pin 2, causing U2 pin 6 to go negative. The ac amplifier output goes negative in response to the dc control input. This continues until the output becomes sufficiently negative to sink all the input current, and return U2 pin 2 to 0 volts. The bridge circuit causes the ac amplifier node to be 0 volts. If the input is +1 volt and the node at the junction of R218 and R223 is 0 volts then the input current is 1/12 I = 8.26 mA. All of this current must flow in R223. Because the node is at 0 volts, the output voltage must be $-8.26\ mA \times 2k\Omega = -16.52V$. Therefore the amplifier voltage gain = R223/R218 = 16.52.

Above about 16 kHz, the ac amplifier controls the summing node directly, sinking or sourcing current through R223 by adjusting the output voltage to hold the node at 0 volts. The ac amplifier gain is also R223/R218 = 16.25. This is divided by 2 at the output terminal, due to the 50Ω source impedance resistors R222 and R224, providing the output is also terminated into 50Ω.

Refer to sheet 7. The top half of the circuit amplifies the positive portion of the signal, and the bottom half amplifies the negative part. Q30 and Q31 form an ac gain stage. An emitter follower stage is formed by Q32 and Q33, to provide a low impedance drive to the second voltage gain stage Q36 and Q39. This stage drives the parallel output emitter followers Q37 and Q38 on the positive side, and Q40 and Q41 on the negative. Diodes CR23 and CR26 set thermally stable bias for the output transistors. Networks R211, R212, C94 and C93 bypass emitter resistor R208, while R245, R246, C107 and C106 bypass R244. As frequency is increased, these components decrease the local negative feedback in the driver stage, increasing the high frequency gain. Voltage regulators VR5 and VR6 have external current limiting circuitry set to limit at about 220 mA to prevent damage in the event of a shorted transistor. When the offset button is depressed, offset current is injected directly into both nodes in proportion to the feedback resistor values. The amplifier responds exactly as described above for a dc input.

4.3.14 Output Attenuator

Refer to sheet 7. Each attenuator button selects an independent voltage divider, which has 50Ω input and output impedances to correctly load the amplifier and to provide a constant 50Ω impedance at the FUNC OUT terminal.

The 10dB attenuator has a 3.16/1 voltage division ratio. The 20dB attenuator has a 10/1 voltage division ratio, and the 40dB stage has a 100/1 ratio. These ratios multiply in voltage. For example if the 20dB and 40dB buttons are depressed, the voltage division ratio is 1000/1. The attenuators add algebraically in dB, therefore any attenuation from 10 to 70dB may be selected in 10dB steps.

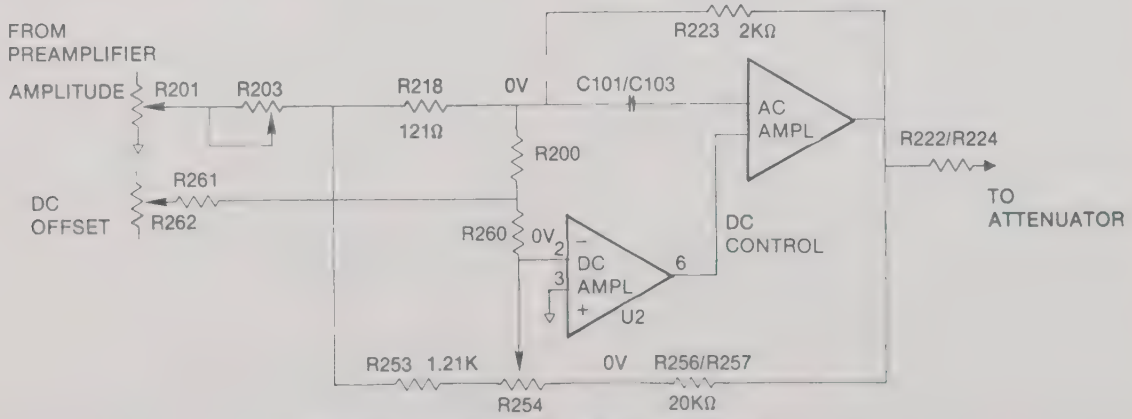


Figure 4-2. Simplified Output Amplifier

SECTION 5
CALIBRATION

5.1 FACTORY REPAIR

Wavetek maintains a factory repair department for those customers not possessing the necessary personnel or test equipment to maintain the instrument. If an instrument is returned to the factory for calibration or repair, a detailed description of the specific problem should be attached to minimize turnaround time.

5.2 REQUIRED TEST EQUIPMENT

Voltmeter . . . . . Millivolt dc measurement (0.1% accuracy), true rms
Oscilloscope, Dual Channel . . . . . 100 MHz bandwidth
Counter . . . . . 20 MHz (0.01% accuracy)
50Ω Feedthru . . . . . ±0.1% accuracy, 2W
Distortion Analyzer . . . . . To 200 kHz
RG58U Coax Cable . . . 3 ft length BNC male contacts
Spectrum Analyzer . . . . . To 20 MHz

5.3 COVER REMOVAL

NOTE

Before removing the covers, disconnect the instrument from the ac power source.

Invert the instrument and remove the four screws in the bottom cover. Remove the bottom cover.

NOTE

Remove the cover only when it is necessary to make adjustments or measurements.

5.4 CALIBRATION

After refering to the following preliminary data, perform calibration, as necessary, per table 5-1. If performing partial calibration, check previous settings and adjustments for applicability. Calibration points are shown in figure 5-1.

1. All measurements made at the FUNCTION OUT connector must be terminated into a 50Ω (±0.1%) load.

WARNING

With the covers removed, dangerous voltage points may be exposed. Contact with any of these points could cause serious injury or death.

2. Start the calibration by removing covers as described in paragraph 5.3, connecting the unit to an ac source and setting these front panel switches as follows:

SYM . . . . . Off (extended)
TRIG LEVEL . . . . . 12 o'clock
DC OFFSET . . . . . Off (extended)
OUTPUT ATTEN . . . . . 0 dB (all extended)

3. Allow the unit to warm up at least 30 minutes for final calibration. Keep the instrument covers on to maintain heat. Remove covers only to make adjustments or measurements.

Table 5-1. Calibration Procedure

Note: Where there are no entries, open column indicates previous entry is applicable.

	Test	Dial	Freq Mult	Vern/ Sym	Mode	Func	Ampl	Test Point	Tester	Adjust	50Ω Load	Result	Remarks
1 (1)	±15V Supply	2.0	1K	cw	CONT	Sqr	cw	See remarks	DVM	Verify	No	30 ± 1.5 Vdc	Read voltage between +15V and −15V on PC board.
1 (2)	±15V Balance	—	—	—	—	—	—	Board +15V	—	R3	—	See remarks	Match +15V and −15V readings within 10mV. Ref gnd is TP7.
1 (3)		—	—	—	—	—	—	Board −15V	—	Verify	—	—	
2	+5V Supply	—	—	—	—	—	—	+5V	—	—	—	+5 ± .75 Vdc	
3	−5V Supply	—	—	—	—	—	—	−5V	—	—	—	−5 ± .75 Vdc	
4	+23V Supply	—	—	—	—	—	—	FB1	—	—	—	+23 ± 1.15 Vdc	
5	−23V Supply	—	—	—	—	—	—	FB2	—	—	—	−23 ± 1.15 Vdc	
6	Power Ampl Zero	—	—	—	—	dc	ccw	FUNC OUT	—	R258	Yes	0 ± 20 mVdc	
7	Preamp Zero	—	—	—	—	—	cw	—	—	R185	—		
8	Top of Dial Symmetry	—	—	—	—	Sqr	—	—	Scope	R96	—	Asym <1μs	Set for min asym. (Set by alternate triggering of scope ± slope.)
9	VCG Null	.02	100K	—	—	—	—	—	—	R65	—	See remarks	Set for min freq shift when VCG is grounded. Repeat steps 8 and 9 as necessary.
10	100:1 Symmetry	—	—	—	—	—	—	—	—	R94	—	Asym <1μs	Set for min asym.
11	1000:1 Frequency	—	—	ccw	—	—	—	—	Counter	R63	—	160 (+0, −20) Hz	
12	Triangle Offset	2.0	1K	cw	—	Tri	—	—	DVM	R17	—	0 ± 20 mVdc	
13 (1)	Sine Distortion	—	—	—	—	Sine	—	—	Dist. Analyzer	R159	—	<.18%	
13 (2)	—	—	10K	—	—	—	—	—		R165 Verify		<.35%	If not <0.35%, perform step 26 and continue with step 13.
14 (1)	Triangle Trigger Baseline	—	1K	—	TRIG	Tri	—	—	DVM	R51	—	0 ± 20 mV	Note reading for use in next step.
14 (2)		Tra-verse	—	—	—	—	—	—	Scope	See remarks	—	Step 14 (1) reading ± 180 mV	Verify the dc limits.
15	Sine Trigger Baseline	—	—	—		Sine					—		
16 (1)	Dial Alignment	2.0	—	—	CONT	Sqr	—	SYNC OUT	Counter	R81	—	2 kHz ± 10 Hz	
16 (2)		0.2	—	—	—	—	—	—	—	Verify	—	100 ± 10 Hz	If satisfactory skip to step 18 (1)
16 (3)		See remarks	—	—	—	—	—	—	—	R81	—	2.088 kHz ± 10 Hz	Remove dial and set the shaf ccw.
16 (4)		—	—	—	—	—	—	—	—	See remarks	—	200 ± 20 Hz	Replace dial, align to 0.2, tighten set screw and verify setting.
17	Dial Tracking	See remarks	1K	—	—	—	—	—	—	Verify	—	Dial mark ± 40 Hz	Verify frequency at each major dial mark.
18 (1)	X10M Frequency	2.0	10M	—	—	—	—	—	Counter	C37	—	200 MHz ± 100 kHz	Optimize C66 value if setting is out of range for C37.
18 (2)		See remarks		—	—	—	—	—	—	Verify	—	Dial mark ± 600 kHz	Verify frequency at each major dial mark. Retouch C37 setting if necessary.

Table 5-1. Calibration Procedure (Continued)

	Test	Dial	Freq Mult	Vern/ Sym	Mode	Func	Ampl	Test Point	Tester	Adjust	50Ω Load	Result	Remarks
19 (1)	X1M Frequency	2.0	1M	cw	CONT	Sqr	—	SYNC OUT	Counter	Verify	Yes	See remarks	Trim C33 to Set 2MHz freq between 2.020 and 2.040MHz.
19 (2)		Major Div.		—	—	—	—	—	—	Verify	—	Dial mark ± 40 kHz	
20	X100K Frequency	2.0	100K	—	—	—	—	—	—	—	—	200 ± 4.0 kHz	Optimize R39 value if necessary.
21	X10K Frequency		10K	—	—	—	—	—	—	Verify	—	20 ± .4 kHz	
22	Capacity Mult Symmetry	0.1	100	—	—	—	—	FUNC OUT	Scope	R106	—	<20μs	Set for min asym. (Veriy important for low freq sine dist.)
23 (1)	Capacity Mult Frequency	2.0		—	—	—	—	SYNC OUT	Counter	R102	—	199.5 ± .5 Hz	
23 (2)		—	10	—	—	—	—	—	—	Verify	—	50 ± 1 ms	Retouch R102 setting if necessary.
23 (3)		—	1	—	—	—	—	—	—	—	—	500 ± 10 ms	
23 (4)		—	0.2	—	—	—	—	—	—	—	—	5s ± 100 ms	
24	Low Frequency Aberrations	—	1K	—	—	—	—	FUNC OUT	Scope	R254	—	See remarks	Adjust the "Corner Shape" for just noticeable peaking.
25 (1)	Function Output Amplitude			—	—	Sine	—	—	DVM	R203	—	5.35 Vrms ± .01V	
25 (2)		.5	100K	—	—	See remarks	—	—	Scope	See remarks	—	15 Vp-p (−0, +1.5V)	Verify sine, tri and sqr ampl.
26	High Frequency Aberrations	—	10M	—	—	Sqr	—	—	Sample Scope	R245 R211	— —	<0.6 Vp-p	Worst case aberrations not to exceed 4% of full ampl for each peak.
27	Square Wave Rise & Fall Time			—	—		—	—		Verify	—	<13ns	
28 (1)	Harmonic Content	See remarks		—	—	Sine	—	—	Spec. Analyzer	—	—	<27 dB	Look for worst case over calibrated dial travel.
28 (2)			1M	—	—	—		—		—	—	<33 dB	
29 (1)	Sine Roll-off	1.0	—	—	—	—	See	—	DVM	AMPLI-TUDE	—	17.5 dBm ± .1 dB	Set OUTPUT ATTN to −10 dB. Set AMPLITUDE to 17.5 dBm ± .1 dB.
29 (2)		See remarks		—	—	—	Hold setting	—	—	See remarks	—	17.5 dBm ± .2 dB	Look for worst case over calibrated dial travel.
29 (3)		—	10M	—	—	—	—	—	—	—	—	175. dBm ± 1 dB	

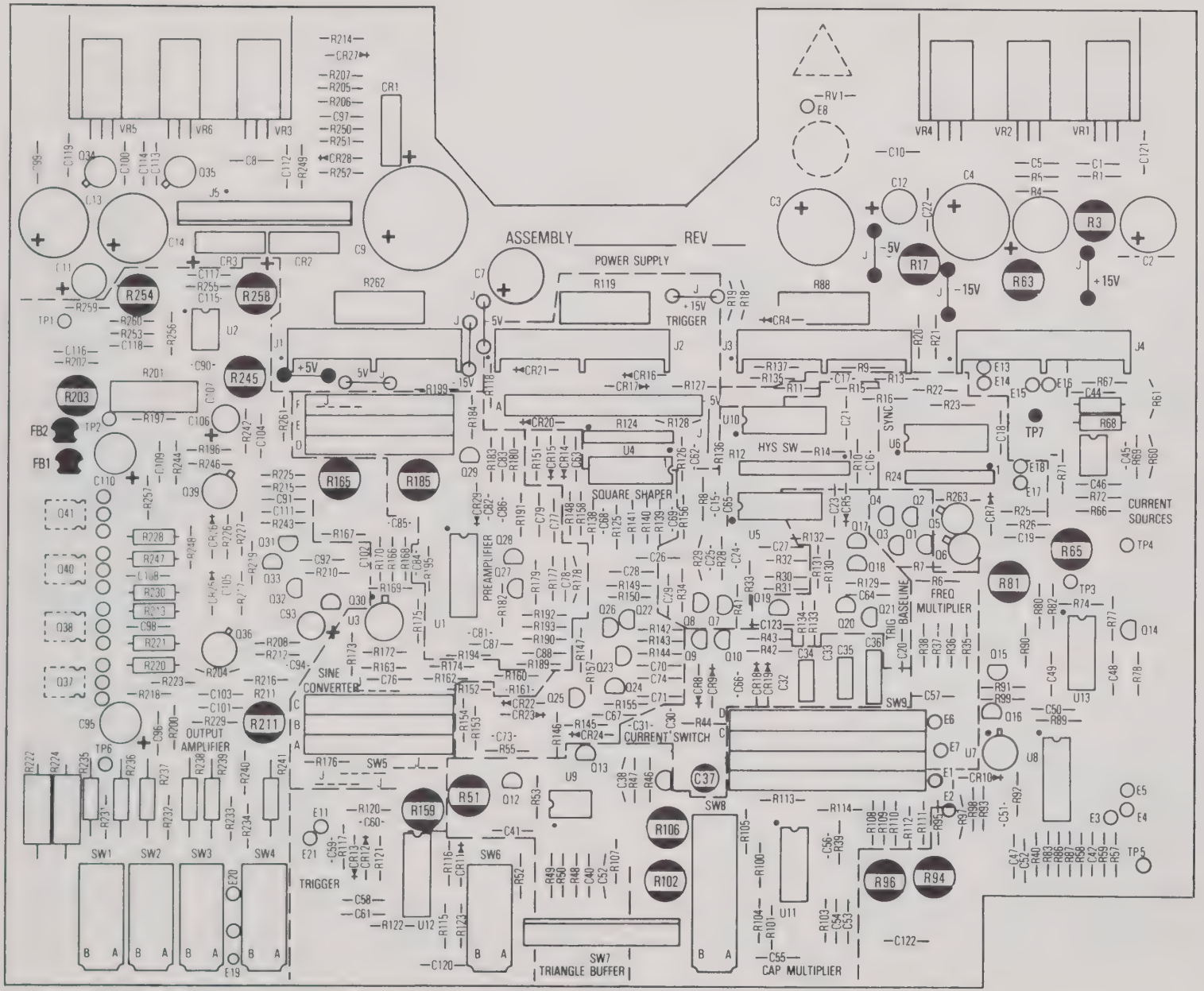


Figure 5-1. Calibration Points

SECTION 6
TROUBLESHOOTING

6.1 FACTORY REPAIR

Wavetek maintains a factory repair department for those customers not possessing the necessary personnel or test equipment to maintain the instrument. If an instrument is returned to the factory for calibration or repair, a detailed description of the specific problem should be attached to minimize turnaround time.

6.2 BEFORE YOU START

Since no troubleshooting guide can possibly cover all the potential problems, the aim of this guide is to give a methodology which, if applied consistently, will lead to the problem area. Therefore, it is necessary to familiarize yourself with the instrument by reviewing the functional description and the detailed circuit description in conjunction with the schematic. Successful troubleshooting depends upon understanding the circuit operation within each functional block as well as the block relationships.

6.3 TROUBLESHOOTING

WARNING

With the covers removed, dangerous voltage points may be exposed. Contact with any of these points could cause serious injury or death.

Table 6-1 gives an index of common symptoms. For each symptom a troubleshooting guide is referenced (Paragraphs 6.3.1 through 6.3.15) that, when correctly followed, will lead to a solution to the problem.

The troubleshooting guide is arranged in three (3) levels:

1. Identify improperly set controls.
2. Isolate the faulty functional blocks.
3. Identify the faulty circuit or component.

Individual component troubleshooting is given in paragraph 6.5, recommended test equipment is given in paragraph 5.2 and circuit schematics are in the back of this manual.

In all problems:

1. Double check for proper control settings.
2. Calibrate or rule out calibration as a problem.
3. Inspect components, wiring and circuit boards for heat damage.
4. Recalibrate as necessary after circuit repair.

Find the instrument symptom in table 6-1 and proceed as directed to the proper troubleshooting paragraph.

Table 6-1. Symptoms

Symptom	Paragraph
Fuse blows, no dial lamp.	6.3.1
Power supply >100 mVp-p ripple or out of specification.	6.3.2
Function out (all functions) distorted or missing.	6.3.3
Square output distorted or missing.	6.3.4
Sine wave output distorted or missing.	6.3.5
Triangle output distorted or missing.	6.3.6
Sync output distorted or missing (FUNC OUT normal).	6.3.7
Excessive high frequency sine or triangle roll off, excessive square wave overshoot and rise/fall time.	6.3.8
Low frequency square wave tilt.	6.3.9
Time symmetry cannot be adjusted within specification.	6.3.10
Frequency accuracy and dial response problems.	6.3.11
Trigger, gate and trigger baseline problems.	6.3.12
Voltage at VCG IN connector not changing frequency properly.	6.3.13
DC offset not functioning correctly.	6.3.14
Variable symmetry problems	6.3.15

6.3.1 Fuse Blows, No Dial Lamp

1. Fuse size incorrect for voltage setting.
2. Line voltage selector incorrectly positioned.
3. Disconnect P5. If ac voltages are now correct, refer to the power supply guide, paragraph 6.4.1. If not, inspect the transformer and power receptacle.

6.3.2 Power Supply >100 mVp-p Ripple or Out of Specification

1. Check line voltage selector for correct position.
2. If the supply is 0V, check for a short between the faulty supply and ground by lifting the jumpers at rear of the board.
3. Lift P5 from the board. If the voltages at P5 are not close to the values shown on the schematic table, inspect the transformer and power receptacle. If the voltages are normal, connect P5, then lift the jumpers (rear of board) for faulty supply. If the supplies are still bad, refer to paragraph 6.4.1. If not, the problem is caused by an excessive current drain by the generator circuits.

6.3.3 All Waveforms at FUNC OUT Distorted or Missing

Improperly set controls:

1. OUTPUT ATTEN or AMPLITUDE controls incorrectly set too low for scope gain or voltmeter range.
2. FUNCTION switch incorrectly set to DC.
3. MODE switch incorrectly set to TRIG or GATE.
4. SYM or DC OFFSET buttons depressed.

Functional block isolation:

1. Verify power supply voltages are within ±5% of nominal, with less than 100 mVp-p of ac ripple. If not, refer to paragraph 6.4.1.
2. Check for a nonlinear triangle. If the triangle is nonlinear on only one range, check for a leaky capacitor on that range. If the triangle is nonlinear in more than one range, check for leaky capacitors or faulty active components in the frequency multiplier and triangle buffer circuits.
3. If the waveform is bad in one of the four lowest ranges (.1, 1, 10, 100), but the remaining ranges are normal, refer to the capacitance multiplier guide 6.4.9.
4. If the waveform is bad only in 1M or 10M FREQ MULT positions, refer to paragraph 6.4.3. If the delay compensation circuit appears normal, refer to figure 6-1.
5. If square wave symmetry, measured at FUNC OUT, is out of specification and cannot be calibrated, refer to paragraph 6.4.10.
6. If none of the above conditions apply, refer to figure 6-1.

6.3.4 Square Wave Distorted or Missing

Improperly set controls:

1. SYM button depressed.
2. Excessive dc offset overdriving output amplifier.

Functional block isolation:

1. Verify power supply voltages are within ±5% of nominal, with less than 100 mVp-p of ac ripple. If not, refer to paragraph 6.4.1.
2. If the waveform is bad in one or more of the four lowest ranges (.1, 1, 10, 100), but the remaining ranges are normal, refer to paragraph 6.4.9.
3. If symmetry is not in specification and cannot be calibrated refer to paragraph 6.3.10.
4. If none of the above conditions apply, refer to figure 6-2.

6.3.5 Sine Wave Distorted or Missing

Improperly set controls:

1. SYM button depressed
2. Excessive dc offset overdriving output amplifier.

Functional block isolation:

1. Verify power supply voltages are within ±5% of nominal, with less than 100 mVp-p of ac ripple. If not, refer to paragraph 6.4.1.
2. Check the triangle for nonlinearity at FUNC OUT. If it is nonlinear, but only on one range, check for a leaky capacitor on that range. If the triangle is nonlinear on more than one range, check for a leaky capacitor or faulty active component in the frequency multiplier and triangle buffer circuits. (NOTE: Some nonlinearity above 200 kHz is normal and not specified.)
3. If the waveform is bad in one or more of the four lowest ranges (.1, 1, 10, 100), but the remaining ranges are normal, refer to paragraph 6.4.9.
4. Verify that square wave symmetry, at FUNC OUT, is in specification. If not and cannot be calibrated, refer to paragraph 6.3.10.
5. If none of the above conditions apply, refer to figure 6-3.

6.3.6 Triangle Distorted or Missing

Improperly set controls:

1. SYM button depressed.
2. Excessive dc offset overdriving output amplifer.

Functional block isolation:

1. Verify power supply voltages are within ±5% of nominal with less than 100 mVp-p of ac ripple. If not, refer to paragraph 6.4.1.

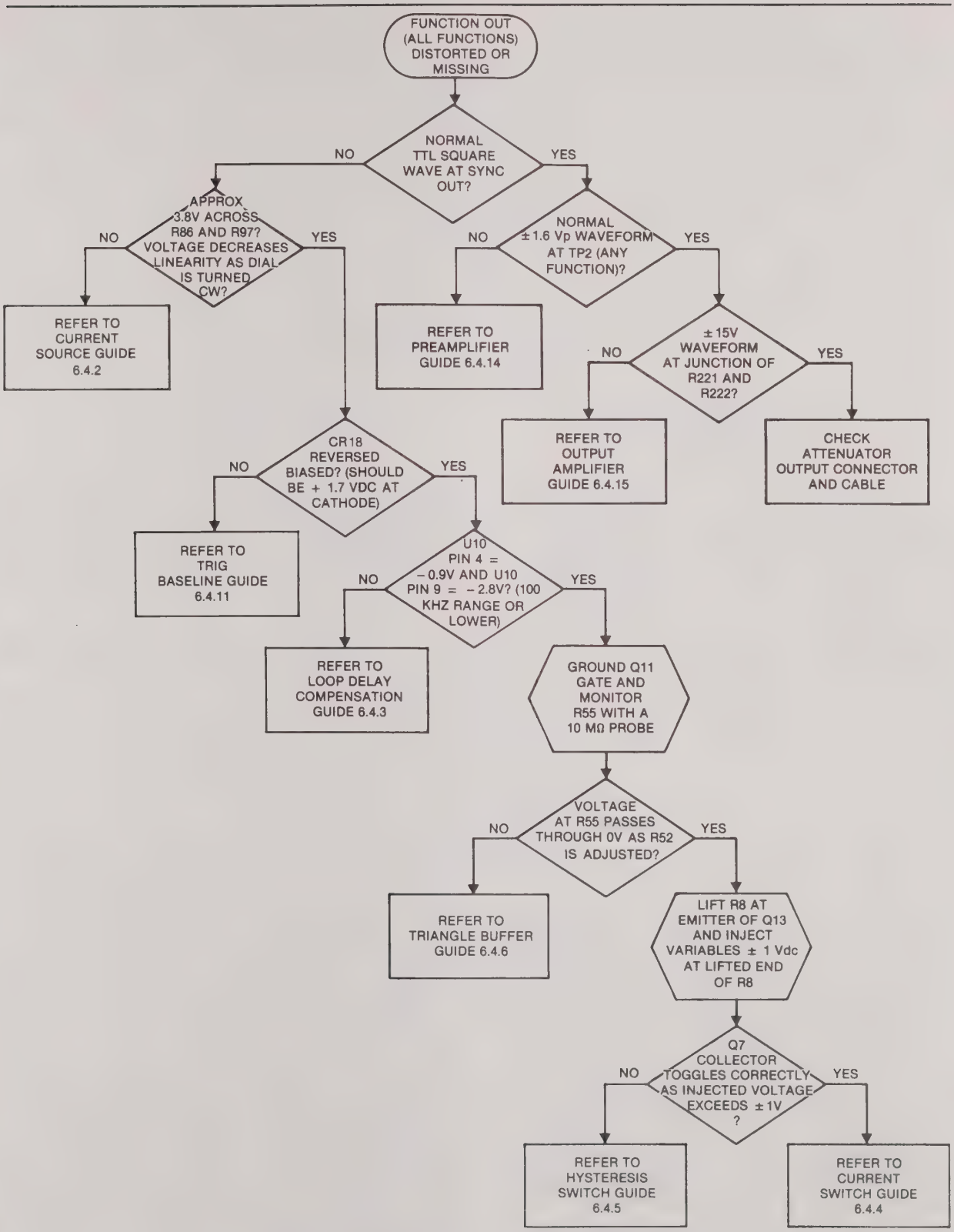

FUNCTION OUT (ALL FUNCTIONS) DISTORTED OR MISSING
NORMAL TTL SQUARE WAVE AT SYNC OUT?
NO
YES
APPROX 3.8V ACROSS R86 AND R97? VOLTAGE DECREASES LINEARITY AS DIAL IS TURNED CW?
NO
YES
REFER TO CURRENT SOURCE GUIDE 6.4.2
NORMAL ±1.6 Vp WAVEFORM AT TP2 (ANY FUNCTION)?
NO
YES
REFER TO PREAMPLIFIER GUIDE 6.4.14
±15V WAVEFORM AT JUNCTION OF R221 AND R222?
NO
YES
REFER TO OUTPUT AMPLIFIER GUIDE 6.4.15
CHECK ATTENUATOR OUTPUT CONNECTOR AND CABLE
CR18 REVERSED BIASED? (SHOULD BE + 1.7 VDC AT CATHODE)
NO
YES
REFER TO TRIG BASELINE GUIDE 6.4.11
U10 PIN 4 = −0.9V AND U10 PIN 9 = −2.8V? (100 KHZ RANGE OR LOWER)
NO
YES
REFER TO LOOP DELAY COMPENSATION GUIDE 6.4.3
GROUND Q11 GATE AND MONITOR R55 WITH A 10 MΩ PROBE
VOLTAGE AT R55 PASSES THROUGH 0V AS R52 IS ADJUSTED?
NO
YES
REFER TO TRIANGLE BUFFER GUIDE 6.4.6
LIFT R8 AT EMITTER OF Q13 AND INJECT VARIABLES ± 1 Vdc AT LIFTED END OF R8
Q7 COLLECTOR TOGGLES CORRECTLY AS INJECTED VOLTAGE EXCEEDS ±1V ?
NO
YES
REFER TO HYSTERESIS SWITCH GUIDE 6.4.5
REFER TO CURRENT SWITCH GUIDE 6.4.4

Figure 6-1. Function Output Troubleshooting

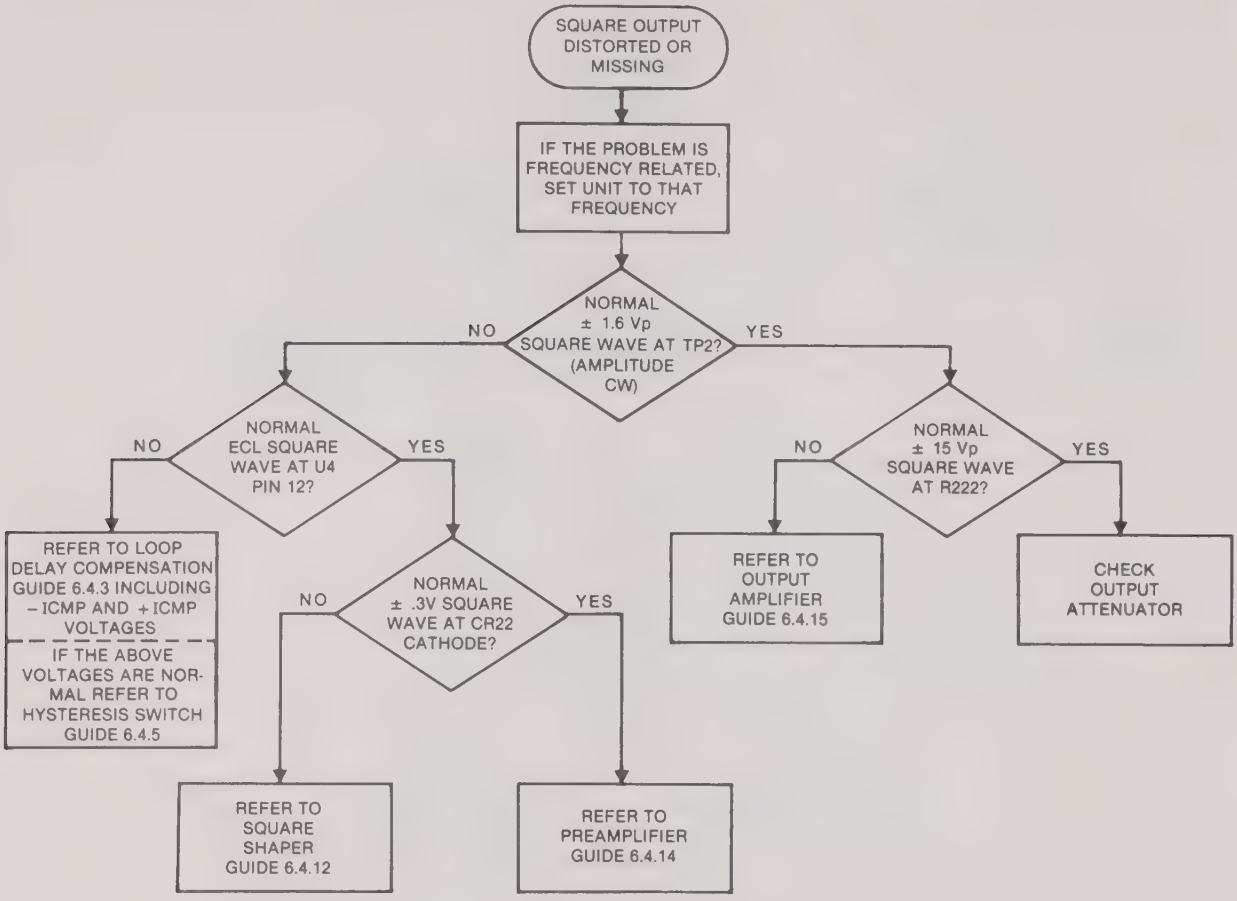

SQUARE OUTPUT DISTORTED OR MISSING
IF THE PROBLEM IS FREQUENCY RELATED, SET UNIT TO THAT FREQUENCY
NORMAL ± 1.6 Vp SQUARE WAVE AT TP2? (AMPLITUDE CW)
NO
YES
NORMAL ECL SQUARE WAVE AT U4 PIN 12?
NO
YES
NORMAL ± 15 Vp SQUARE WAVE AT R222?
NO
YES
REFER TO LOOP DELAY COMPENSATION GUIDE 6.4.3 INCLUDING – ICMP AND + ICMP VOLTAGES
IF THE ABOVE VOLTAGES ARE NORMAL REFER TO HYSTERESIS SWITCH GUIDE 6.4.5
NORMAL ± .3V SQUARE WAVE AT CR22 CATHODE?
NO
YES
REFER TO OUTPUT AMPLIFIER GUIDE 6.4.15
CHECK OUTPUT ATTENUATOR
REFER TO SQUARE SHAPER GUIDE 6.4.12
REFER TO PREAMPLIFIER GUIDE 6.4.14

Figure 6-2. Square Output Troubleshooting

2. Check the triangle for nonlinearity at FUNC OUT. If it is nonlinear, but only on one range, check for a leaky capacitor on that range. If the triangle is nonlinear on more than one range, check for a leaky capacitor or faulty active component in the frequency multiplier and triangle buffer circuits. (NOTE: Some nonlinearity above 200 kHz is normal and not specified.)
3. If the waveform is bad in one or more of the four lowest ranges (.1, 1, 10, 100), but the remaining ranges are normal, refer to paragraph 6.4.9.
4. Verify square wave symmetry at FUNC OUT is in specification. If not and cannot be calibrated, refer to paragraph 6.3.10.
5. If none of the above conditions apply, refer to figure 6-4.

6.3.7 Sync Output Distorted or missing (FUNC OUT Normal)

Improperly set controls:

1. Because the FUNC OUT is normal, this cannot be caused by improperly set controls.

Functional block isolation:

1. If there is no ECL square wave at U6 pin 10, refer to paragraph 6.4.7. If there is an ECL square wave, refer to paragraph 6.4.8.

6.3.8 Excessive High Frequency Sine or Triangle Roll Off

Improperly set controls:

1. Excessive dc offset overdriving output amplifier.

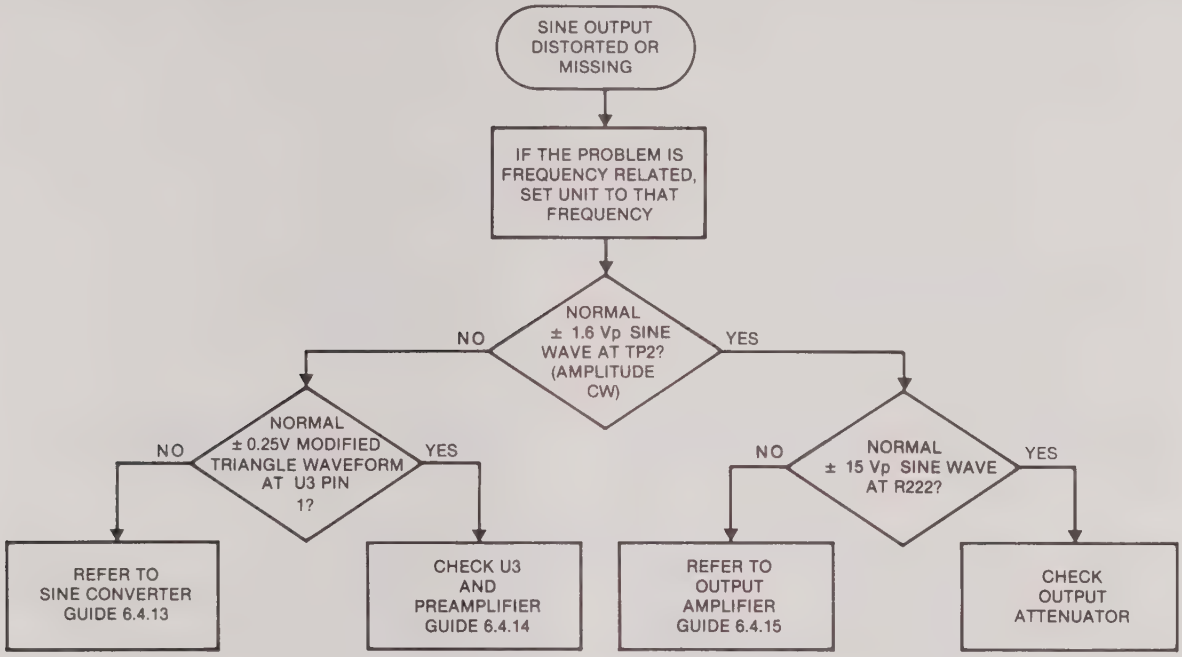

SINE OUTPUT DISTORTED OR MISSING
IF THE PROBLEM IS FREQUENCY RELATED, SET UNIT TO THAT FREQUENCY
NORMAL ± 1.6 Vp SINE WAVE AT TP2? (AMPLITUDE CW)
NO
YES
NORMAL ± 0.25V MODIFIED TRIANGLE WAVEFORM AT U3 PIN 1?
NO
YES
NORMAL ± 15 Vp SINE WAVE AT R222?
NO
YES
REFER TO SINE CONVERTER GUIDE 6.4.13
CHECK U3 AND PREAMPLIFIER GUIDE 6.4.14
REFER TO OUTPUT AMPLIFIER GUIDE 6.4.15
CHECK OUTPUT ATTENUATOR

Figure 6-3. Sine Output Troubleshooting

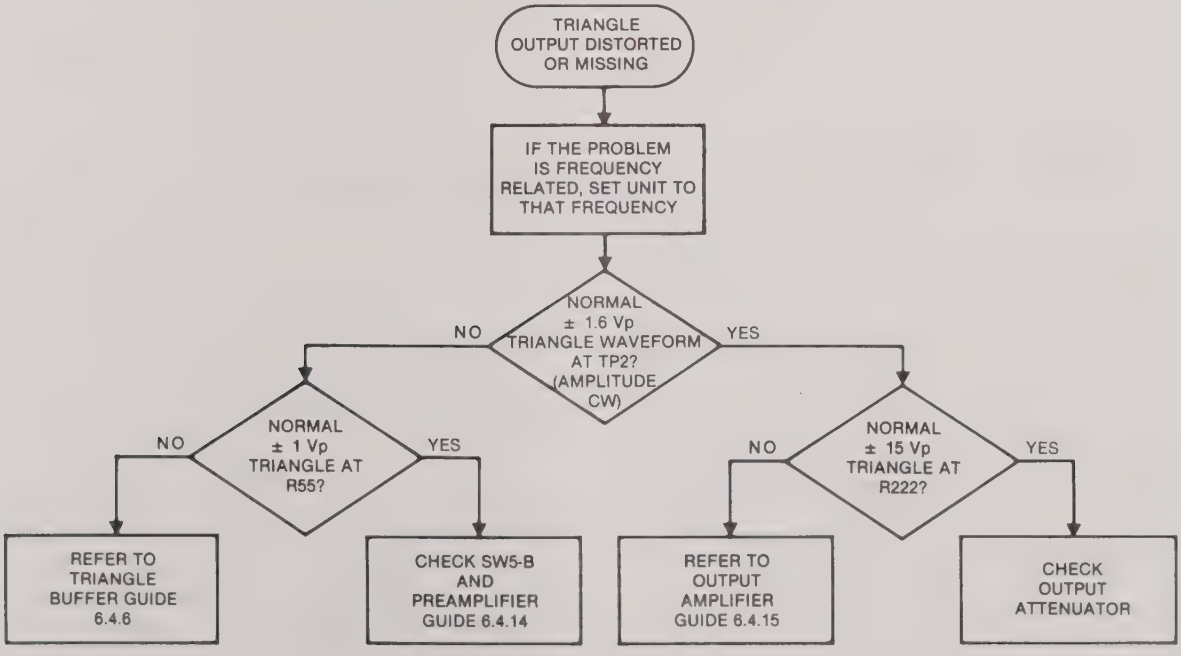

TRIANGLE OUTPUT DISTORTED OR MISSING
IF THE PROBLEM IS FREQUENCY RELATED, SET UNIT TO THAT FREQUENCY
NORMAL ± 1.6 Vp TRIANGLE WAVEFORM AT TP2? (AMPLITUDE CW)
NO
YES
NORMAL ± 1 Vp TRIANGLE AT R55?
NO
YES
NORMAL ± 15 Vp TRIANGLE AT R222?
NO
YES
REFER TO TRIANGLE BUFFER GUIDE 6.4.6
CHECK SW5-B AND PREAMPLIFIER GUIDE 6.4.14
REFER TO OUTPUT AMPLIFIER GUIDE 6.4.15
CHECK OUTPUT ATTENUATOR

Figure 6-4. Triangle Output Troubleshooting

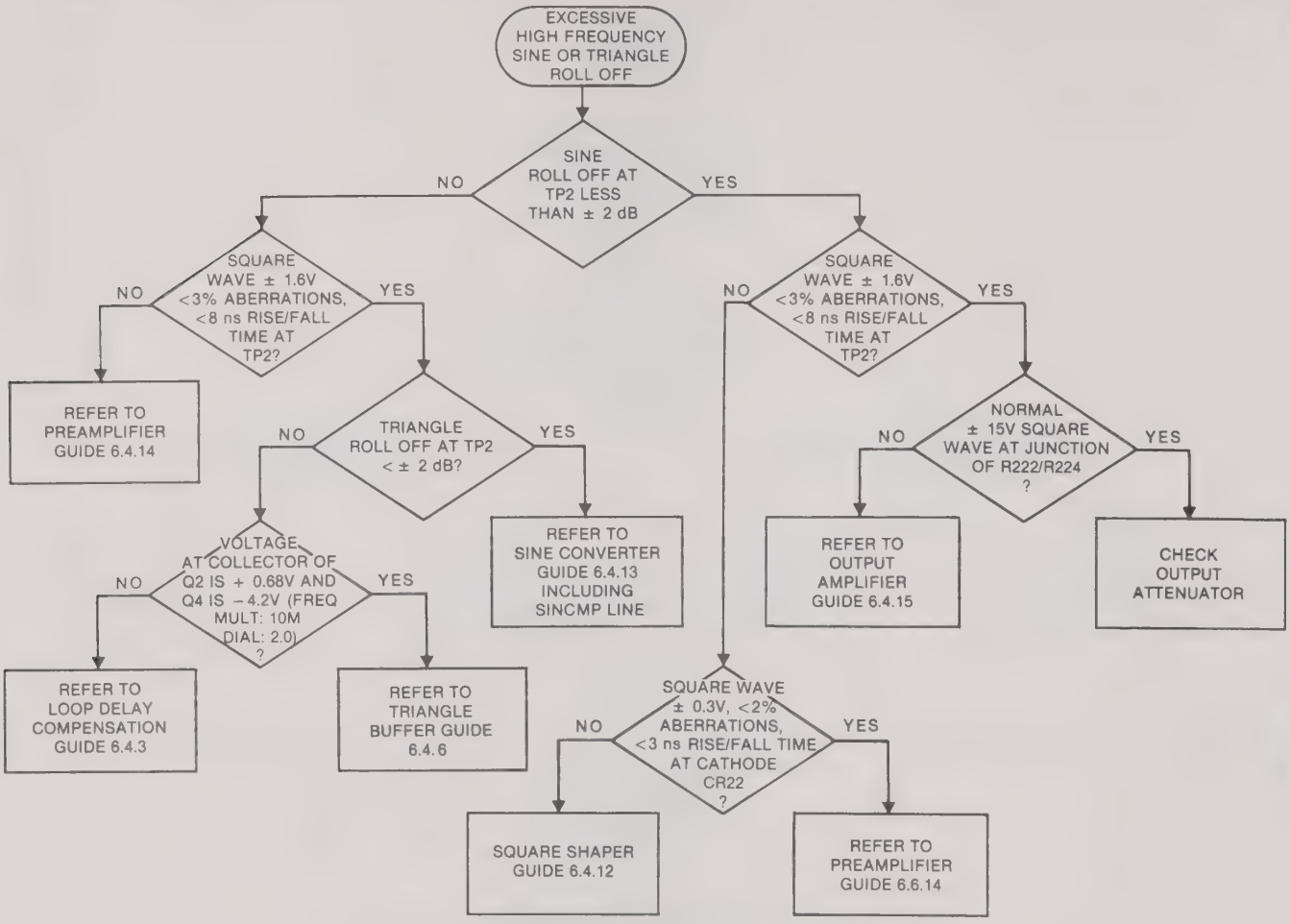

EXCESSIVE HIGH FREQUENCY SINE OR TRIANGLE ROLL OFF
SINE ROLL OFF AT TP2 LESS THAN ± 2 dB
NO
YES
SQUARE WAVE ± 1.6V <3% ABERRATIONS, <8 ns RISE/FALL TIME AT TP2?
NO
YES
REFER TO PREAMPLIFIER GUIDE 6.4.14
TRIANGLE ROLL OFF AT TP2 < ± 2 dB?
NO
YES
REFER TO SINE CONVERTER GUIDE 6.4.13 INCLUDING SINCMP LINE
VOLTAGE AT COLLECTOR OF Q2 IS + 0.68V AND Q4 IS −4.2V (FREQ MULT: 10M DIAL: 2.0) ?
NO
YES
REFER TO LOOP DELAY COMPENSATION GUIDE 6.4.3
REFER TO TRIANGLE BUFFER GUIDE 6.4.6
SQUARE WAVE ± 1.6V <3% ABERRATIONS, <8 ns RISE/FALL TIME AT TP2?
NO
YES
NORMAL ± 15V SQUARE WAVE AT JUNCTION OF R222/R224 ?
NO
YES
REFER TO OUTPUT AMPLIFIER GUIDE 6.4.15
CHECK OUTPUT ATTENUATOR
SQUARE WAVE ± 0.3V, <2% ABERRATIONS, <3 ns RISE/FALL TIME AT CATHODE CR22 ?
NO
YES
SQUARE SHAPER GUIDE 6.4.12
REFER TO PREAMPLIFIER GUIDE 6.6.14

Figure 6-5. High Frequency Waveform Troubleshooting

2. Verify 50Ω load on the cable at oscilloscope end.

Functional block isolation:

1. Verify power supply voltages are within ±5% of nominal with less than 100 mVp-p of ac ripple. If not refer to paragraph 6.4.1. Use a X10 probe with a very short ground lead and a spectrum analyzer, RF voltmeter or a 200 MHz bandwidth scope when performing sine or triangle roll-off tests.
2. If none of the above conditions apply, refer to figure 6-5.

6.3.9 Low Frequency Square Wave Tilt

Improperly set controls:

1. Scope improperly set to ac.

Functional block isolation:

1. Verify power supply voltages are within ±5% of nominal, and less than 100 mVp-p of ac ripple. If not, refer to paragraph 6.4.1
2. If none of the above conditions apply, refer to figure 6-6.

6.3.10 Time Symmetry Cannot Be Adjusted To Within Specifications

Improperly set controls:

1. SYM button depressed.

Functional block isolation:

1. Verify power supply voltages are within ±5% of nominal, with less than 100 mVp-p of ac ripple. If not, refer to paragraph 6.4.1.

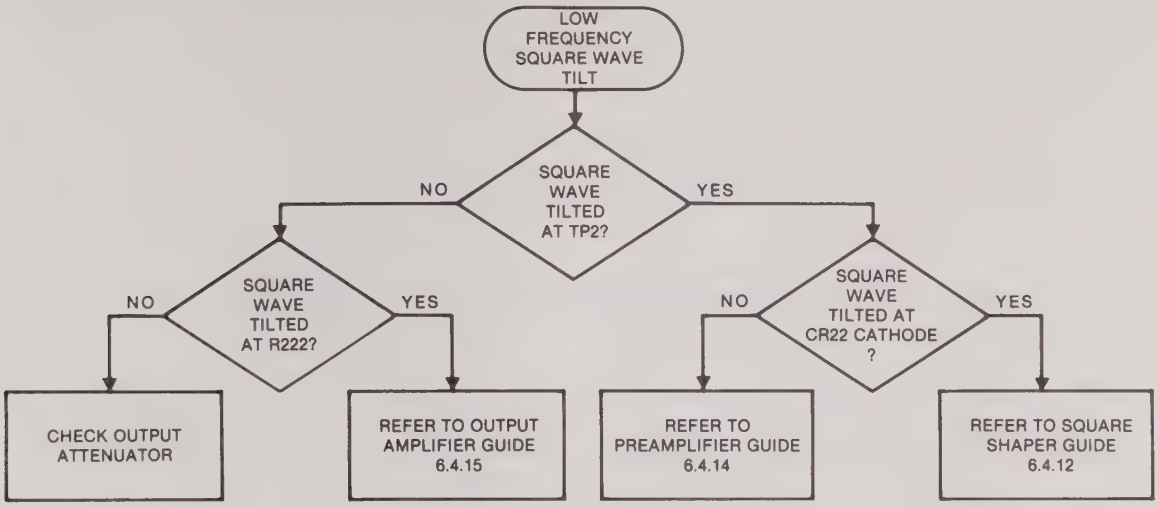


Figure 6-6. Low Frequency Square Wave Troubleshooting

2. If symmetry is out of specification in one of the four lowest ranges (.1, 1, 10, 100), but the remaining ranges are normal, refer to paragraph 6.4.9.
3. If symmetry is out of specification on FREQ MULT settings 1M or 10M only, refer to paragraph 6.4.3.
4. If the voltages across R86 and R97 are not equal (typically 3.8V, Freq Dial: 2.0 Freq Mult: 100K or less), refer to paragraph 6.4.2.

6.3.11 Frequency Accuracy and Dial Response Problems

Improperly set controls:

1. SYM button depressed.
2. External signal connected to VCG in BNC.
3. VERNIER not in FREQ CAL position.

Functional block isolation:

1. Verify power supply voltages are within ±5% of nominal with less than 100 mVp-p ac ripple. If not, refer to paragraph 6.4.1.
2. If the problem occurs in one of the four lowest frequency ranges (.1, 1, 10, 100), but the remaining ranges are normal, refer to paragraph 6.4.9.
3. If the frequency accuracy is out of specification on FREQ MULT settings 1M and 10M, refer to paragraph 6.4.3.
4. If the frequency is out of specification, but only on one range, check the range capacitor for that range.
5. If the problem occurs on the 1K, 10K, or 100K range, check the range capacitor.
6. On the 1K range and frequency dial set at 2.0, check for 3.8V across R86 and R97. As the dial is rotated, this voltage should linearly track the dial settings within ±3% of full scale. If not, refer to paragraph 6.4.2.
7. If none of the above conditions apply, refer to figure 6-7.

6.3.12 Trigger, Gating and Trigger Baseline Problems.

Improperly set controls:

1. MODE incorrectly set to CONT.
2. FUNCTION incorrectly set to DC.
3. DC OFFSET overdriving output amplifier.

Functional block isolation:

1. Verify power supply voltages are within ±5% of nominal, with less than 100 mVp-p of ac ripple. If not, refer to paragraph 6.4.1.
2. If the trigger baseline cannot be calibrated within specification, set MODE to GATE and monitor the emitter of Q19. With TRIG IN disconnected, rotate the TRIG LEVEL ccw. The voltaged should go about −0.7 Vdc. Rotating the TRIG LEVEL cw should change this voltage to about +1.8 Vdc. If these voltage readings are normal, check CR18 and CR19.

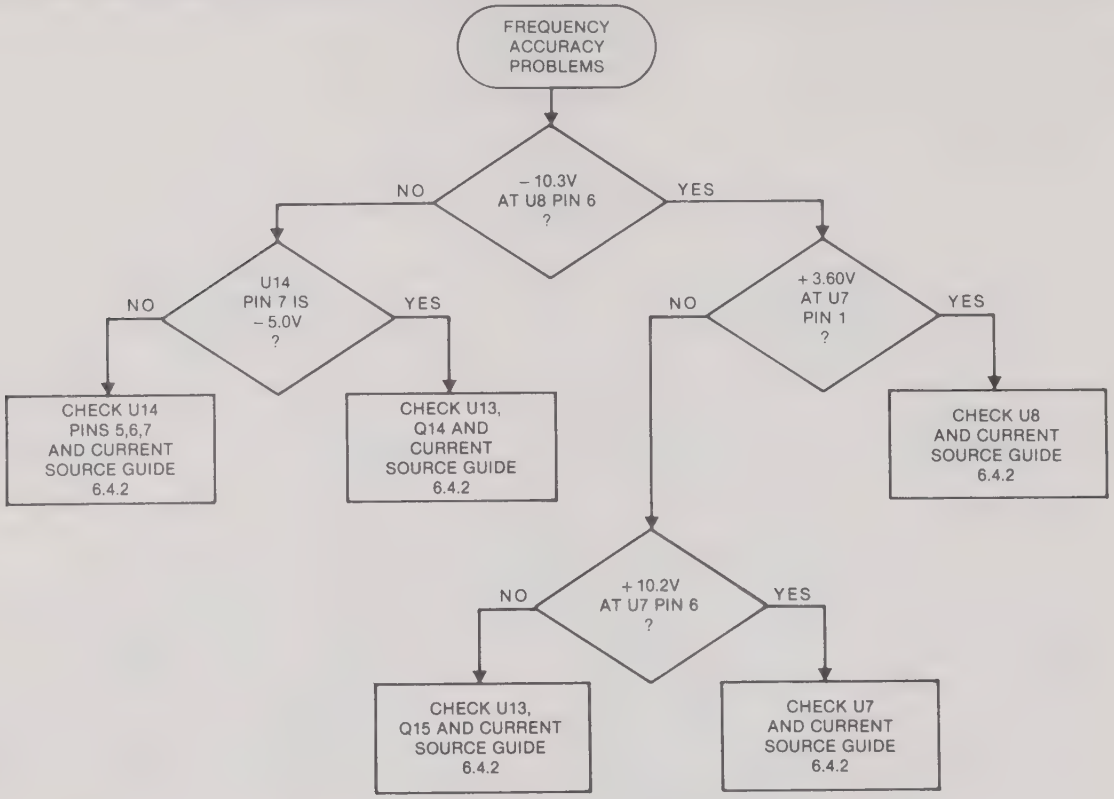

FREQUENCY ACCURACY PROBLEMS
– 10.3V AT U8 PIN 6 ?
NO
YES
U14 PIN 7 IS – 5.0V ?
NO
YES
+ 3.60V AT U7 PIN 1 ?
NO
YES
CHECK U14 PINS 5,6,7 AND CURRENT SOURCE GUIDE 6.4.2
CHECK U13, Q14 AND CURRENT SOURCE GUIDE 6.4.2
CHECK U8 AND CURRENT SOURCE GUIDE 6.4.2
+ 10.2V AT U7 PIN 6 ?
NO
YES
CHECK U13, Q15 AND CURRENT SOURCE GUIDE 6.4.2
CHECK U7 AND CURRENT SOURCE GUIDE 6.4.2

Figure 6-7. Frequency Accuracy Troubleshooting

3. If none of the above conditions apply, refer to figure 6-8.
4. For high frequency (1M and 10M ranges) trigger or gate problems, set the controls as follows:

Frequency Dial	2.0
FREQ MULT:	10M
SYM:	OFF
MODE:	TRIG or GATE (Depends on symptom-GATE preferred)
TRIG LEVEL:	12 o'clock

Set the scope as follows:

Horizontal:	20 ns/div
Vertical:	1 V/div

Inject a 15 MHz 1 Vp-p trigger signal and refer to figure 6-9.

6.3.13 Voltage At VCG IN Connector Not Changing Frequency Properly

Improperly set controls:

1. Excessive VCG IN voltage for dial setting (maximum input voltage is +5.0 Vdc with the dial set at .02 and the Freq VERNIER turned ccw).

Functional block isolation:

1. Set the frequency dial to 2.0, FREQ MULT to 1K, and VCG IN with no input. Measure voltage across R86 and R97 (+3.8 Vdc). In addition, as the frequency dial is rotated, the voltage linearly tracks the dial settings within ±3% full scale. If it functions properly, check R67, R68, R69 and associated circuitry, but if not, refer to paragraph 6.3.11.

6.3.14 DC Offset Not Functioning Correctly

Improperly set controls:

1. Signal peak plus offset exceeding + or – 7.5V (with a 50Ω load), or ± 15V open circuit.
2. Check OUTPUT ATTEN since this also attenuates output offset.

Functional block isolation:

1. Verify power supply voltages are within ±5% of

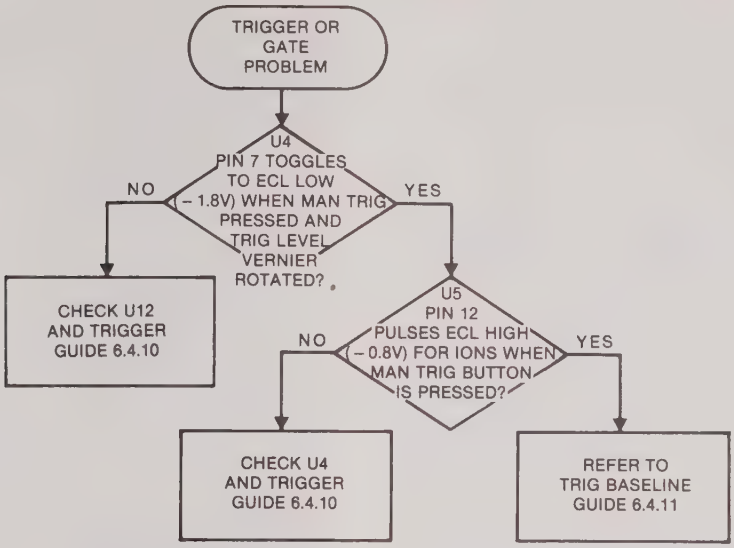

TRIGGER OR GATE PROBLEM
U4 PIN 7 TOGGLES TO ECL LOW (– 1.8V) WHEN MAN TRIG PRESSED AND TRIG LEVEL VERNIER ROTATED?
NO
YES
CHECK U12 AND TRIGGER GUIDE 6.4.10
U5 PIN 12 PULSES ECL HIGH (– 0.8V) FOR IONS WHEN MAN TRIG BUTTON IS PRESSED?
NO
YES
CHECK U4 AND TRIGGER GUIDE 6.4.10
REFER TO TRIG BASELINE GUIDE 6.4.11

Figure 6-8. Trigger Gate Troubleshooting

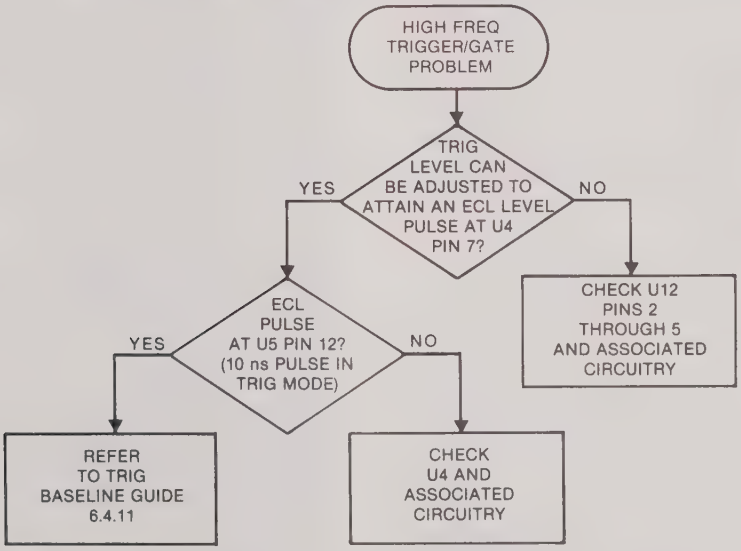

HIGH FREQ TRIGGER/GATE PROBLEM
TRIG LEVEL CAN BE ADJUSTED TO ATTAIN AN ECL LEVEL PULSE AT U4 PIN 7?
YES
NO
CHECK U12 PINS 2 THROUGH 5 AND ASSOCIATED CIRCUITRY
ECL PULSE AT U5 PIN 12? (10 ns PULSE IN TRIG MODE)
YES
NO
REFER TO TRIG BASELINE GUIDE 6.4.11
CHECK U4 AND ASSOCIATED CIRCUITRY

Figure 6-9. High Frequency Trigger/Gate Troubleshooting

nominal with less than 100 mVp-p of ac ripple. If not, refer to paragraph 6.4.1.

2. Take the following voltage measurements with the DC OFFSET button depressed and the DC OFFSET control rotated cw:

   a) The junction of R260 and C116 should vary from +8.0V to −8.0V.

   b) U2 pin 2 should hold at 0.0V.

   c) U2 pin 6 should vary from −1.0V to +1.0V. (Drifting of this voltage is typical because of constant compensation by U2 of variations in output transistor currents.)

3. If none of the above conditions apply, refer to paragraph 6.4.15.

6.3.15 Variable Symmetry Problems

Improperly set controls:

1. SYM button is incorrectly extended.
2. Note: When SYM is depressed the output frequency should be one-tenth the selected frequency.
3. DC offset is overdriving the output amplifier.

Functional block isolation:

1. Verify power supply voltages within ±5% of nominal with less than 100 mVp-p of ac ripple. If not, refer to paragraph 6.4.1.
2. When the voltage at the right leg of R88 (VERNIER/SYM CW) is −15V and when the voltage at the left leg of R88 (VERNIER/SYM) is −15V, refer to paragraph 6.4.2. If not, check R88 and SW8.

6.4 CIRCUIT GUIDES

Circuit guides provide listings of voltage levels, waveforms, and hints that, when used with the schematics, are helpful in isolating faulty circuits. Table 6-2 is an index of circuit guides.

Table 6-2. Circuit Guide Index

Circuit Guide	Paragraph
Power Supply	6.4.1
Current Source	6.4.2
Loop Delay Compensation	6.4.3
Current Switch	6.4.4
Hysteresis Switch	6.4.5
Triangle Buffer	6.4.6
Zero Crossing Detector	6.4.7
Sync	6.4.8
Capacitance Multiplier	6.4.9
Trigger	6.4.10
Trig Baseline	6.4.11
Square Shaper	6.4.12
Sine Converter	6.4.13
Preamplifier	6.4.14
Output Amplifier	6.4.15

6.4.1 Power Supply Guide

1. To determine a faulty power supply, check for the voltages given in table 6-3.
2. If the regulator input is bad, remove P5 and check for:
   a. Shorted or open diodes (CR1, CR2, or CR3).
   b. Shorted or open capacitors at the input of the regulator.
   c. Short between the regulator metal mounting tab and chassis ground.
3. If the regulator input is good, check for:
   a. Shorted or open capacitors at the output of the regulator.
   b. Short between regulator metal mounting tab and chassis ground.
   c. Excessive loading by main board circuits; to verify, lift jumper of the appropriate supply.
   d. If all of the above conditions appear normal, replace the voltage regulator.

Table 6-3. Power Supply Checks

Supply	Voltage Tolerance	Maximum Regulator Input Ripple (p-p)	Maximum Regulator Output Ripple (p-p)
±15V Balance	30 ± 1.5 Vdc (a)	——	——
+15V	(b)	1.5 Vac	10 mV
−15V	(c)	1.5 Vac	10 mV
+5V	±750 mV	1.5 Vac	10 mV
−5V	±750 mV	1.5 Vac	10 mV
+23V	±1.15 Vdc	1.5 Vac	10 mV
−23V	±1.15 Vdc	1.5 Vac	10 mV

(a) Measured between +15V and −15V supplies.
(b) Measure and note +15V supply (V_{+15}).
(c) −15V supply = $-|V_{+15} \pm .01V|$.

6.4.2 Current Source Guide

Top of Dial Check: Set the controls as follows; then perform the checks in table 6-4.

Control	Setting
Frequency Dial	2.0
FREQ MULT	1K
VERNIER	FREQ CAL
SYM	Off (extended)
VCG IN	Disconnected

VCG Check: Set the controls as follows; then perform the checks in table 6-5.

Control	Setting
Frequency Dial	.02
FREQ MULT	1K
VERNIER	Full ccw
SYM	Off (extended)
VCG IN	+5.0 Vdc input

Table 6-4. Current Source Check (Top of Dial)

Test Point	Desired Results
U14 pin 7	−5 ± .5 Vdc
U13 pins 1, 2	−5 ± .5 Vdc
Measure across R83	+3.8 ± .38 Vdc
U8 pin 6	−10.3 ± 1.03 Vdc
Measure across R84 and R93	+3.8 ± .38 Vdc
U13 pin 6	0 ± .01 Vdc
U7 pin 6	+10.2 ± 1.02 Vdc
Measure across R86 and R97	+3.8 ± .38 Vdc

Table 6-5. Current Source (VCG IN)

Test Point	Desired Results
U7 pin 6	+14.38 ± 1.44 Vdc
U8 pin 6 (disconnect VCG IN)	−14.3 ± 1.43 Vdc

10 MHz Range Check: Set the controls as shown below, then perform the checks in table 6-6.

Control	Setting
Frequency Dial	2.0
FREQ MULT	10M
VERNIER	FREQ CAL
SYM	Off (extended)
VCG IN	Disconnected

Table 6-6. Current Source Check (10 MHz Range)

Test Point	Desired Results
Measure across R99	+5.9 ± .59 Vdc
Measure across R83	+6.05 ± .61 Vdc
U8 pin 6	−8.2 ± .82 Vdc

Variable Symmetry Check: Set the controls as shown then measure the voltage across resistors R84, R85, R86, R87, R93, and R97. The measured voltages should read +0.38 ± .04V.

Control	Setting
Frequency Dial	2.0
VERNIER	12 o'clock position
VCG IN	Disconnected
FREQ MULT	1K
SYM	On (depressed)

6.4.3 Loop Delay Compensation Guide

Set the controls as shown; then perform the checks in table 6-7.

Control	Setting
Frequency Dial	2.0
VERNIER	FREQ CAL
VCG IN	Disconnected
FREQ MULT	10M
SYM	Off (extended)

Table 6-7. Loop Delay Compensation Checks

Test Point	Desired Results
Q1 and Q2 emitters	+ 9.2 ± .92 Vdc
Q1 base and collector, Q2 base	+8.5 ± .9 Vdc
Q2 collector	+0.68 ± .07 Vdc
Q3 and Q4 emitter	−9.05 ± .91 Vdc
Q3 and Q4 base Q3 collector	−8.32 ± .83 Vdc
Q4 collector U10 pin 4	−4.2 ± .42 Vdc −1.6 ± .16 Vdc (+ Peak reference)
U10 pin 9	−2.17 ± .22 Vdc (− Peak reference)

6.4.4 Current Switch Guide

Set the controls as shown; then take waveform measurements. Refer to figure 6-10.

Control	Setting
Frequency Dial	2.0
FREQ MULT	1K
SYM	Off (extended)
MODE	CONT

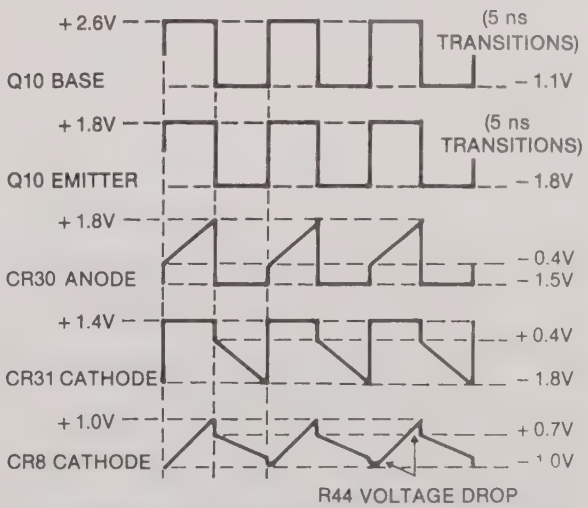


Figure 6-10. Current Switch Waveforms

6.4.5 Hysteresis Switch Guide

Set the controls as shown; then perform the checks in table 6-8 and take waveform measurements. Refer to figure 6-11.

Control	Setting
Frequency Dial	2.0
FREQ MULT	1K
SYM	Off
MODE	CONT

Table 6-8. Hysteresis Switch Guide

Test Point	Desired Results
U10 pin 4	−0.9 ± .09 Vdc (+ Peak reference)
U10 pin 9	−2.8 ± .28 Vdc (− Peak reference)
Q7 and Q8 emitters	−3.0 ± .3 Vdc

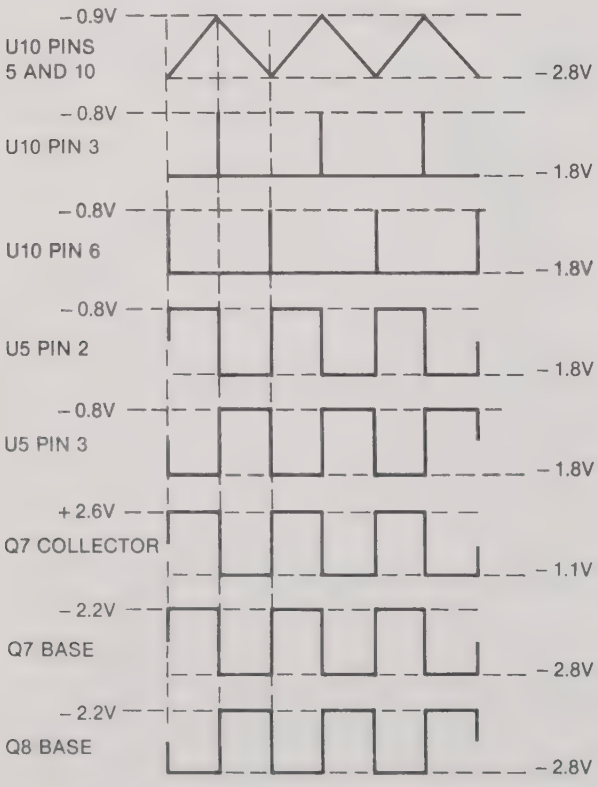


Figure 6-11. Hysteresis Switch Waveforms

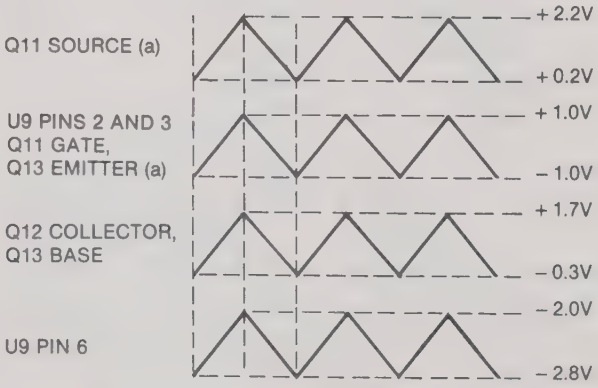
6.4.6 Triangle Buffer Guide

Set the controls as shown; then perform the checks in table 6-9 and take waveform measurements. Refer to figure 6-12. If, after setting the controls, the generator loop does not run, lift R45 at E23 and inject a ± 1.0V triangle into R45.

Control	Setting
Frequency Dial	2.0
FREQ MULT	1K
SYM	Off
MODE	CONT

Table 6-9. Triangle Buffer Checks

Test Point	Desired Results
Q11 drain	+6.5 ± .65 Vdc
Q12 emitter	0.3 ± .03 Vp-p trianle, offset −10 ± 1 Vdc
Q12 base	0.3 ± .03 Vp-p triangle, offset −9.3 ± .9 Vdc
Q13 collector	+5.0 ± .5 Vdc



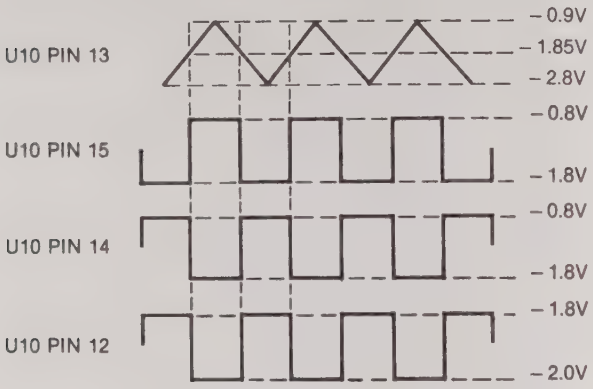
(a) Requires a X10 Probe (high impedance)

Figure 6-12. Triangle Buffer Waveforms

6.4.7 Zero Crossing Detector Guide

Set the controls as shown; then take waveform measurements. Refer to figure 6-13.

Control	Setting
Frequency Dial	2.0
FREQ MULT	1K
SYM	Off
MODE	CONT



(In TRIG mode, no input, voltage is – 1.2 Vdc.)

Figure 6-13. Zero Crossing Detector Waveforms

6.4.8 Sync Guide

Set the controls as shown then perform the checks in table 6-10 and take waveform measurements. See figure 6-14.

Control	Setting
Frequency Dial	2.0
FREQ MULT	1K
SYM	Off
MODE	CONT

Table 6-10. Sync Check

	Desired Results	
Test Point	Function: Sine or Triangle Wave	Function: Square Wave
CR4 cathode	+ 1.2 ± .12 Vdc	– 5 ± .5 Vdc
U6 pins 4 and 6	– 1 ± .1 Vdc	– 4.3 ± .43 Vdc
U6 pins 2 and 11	– 1.8 ± .18 Vdc	– 0.8 ± .08 Vdc
Q5/Q6 emitters	– 1.6 ± .16 Vdc	– 1.6 ± .16 Vdc

6.4.9 Capacitance Multiplier Guide

Set the controls as shown; then take the waveform measurements. Refer to figure 6-15.

Control	Setting
Frequency Dial	2.0
FREQ MULT	100
SYM	Off
MODE	CONT

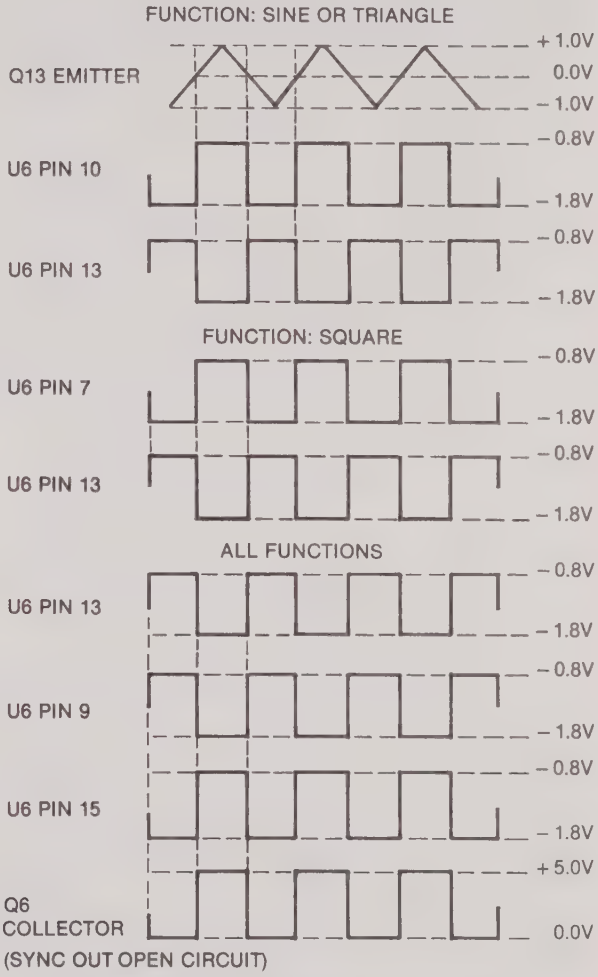


Figure 6-14. Sync Waveforms

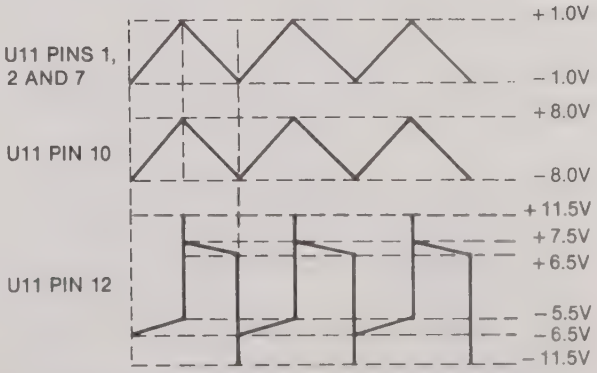


Figure 6-15. Capacitance Multiplier Waveforms

6.4.10 Trigger Guide

TRIG or CONT Check: Set the controls as shown; then take the waveform measurements. Refer to figure 6-16

Control	Setting
Frequency Dial	2.0
FREQ MULT	1K
MODE	TRIG or CONT
TRIG IN	±1V 1 kHz Square wave

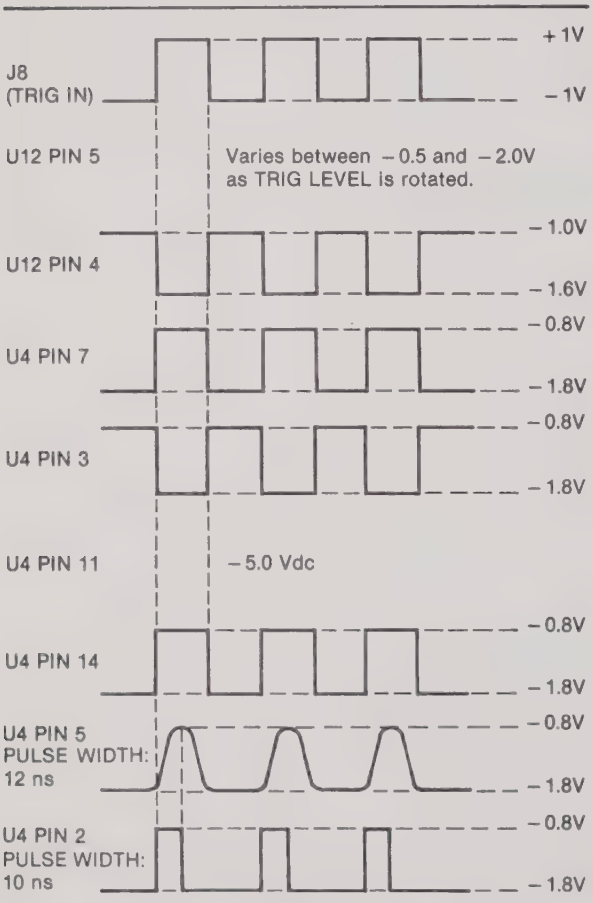


Figure 6-16. Trigger Waveforms (TRIG or CONT)

GATE Checks: Set the controls as shown; then take the waveform measurements. Refer to figure 6-17.

Control	Setting
Frequency Dial	2.0
FREQ MULT	1K
MODE	GATE
TRIG IN	±1V 1 kHz Square wave

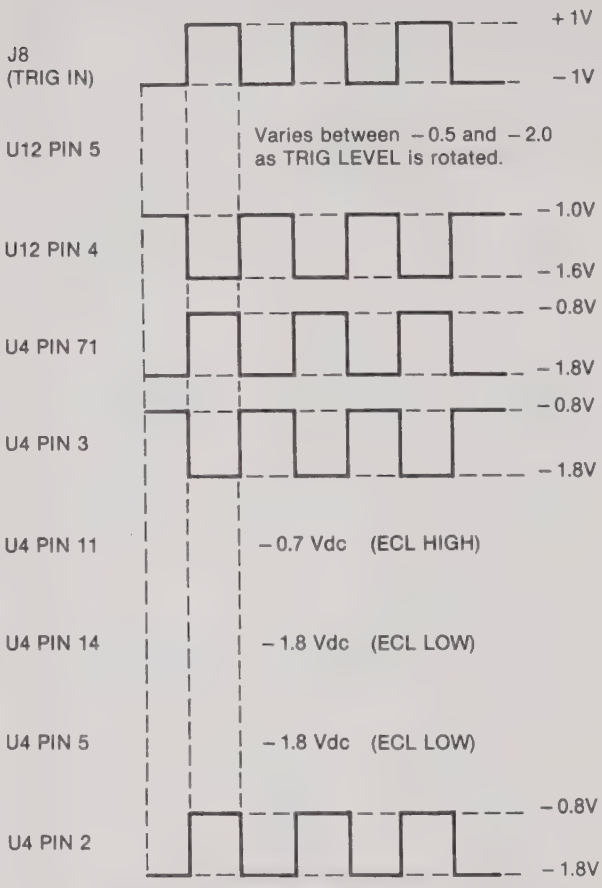


Figure 6-17. Trigger Waveforms (Gate)

6.4.11 Trigger Baseline Guide

Trigger or Gate Mode Problems: Set the controls as shown; then take the waveform measurements. Refer to figure 6-18.

Control	Setting
Frequency Dial	2.0
FREQ MULT	10K
SYM	Off
MODE	TRIG or GATE (Depends on symptom—GATE preferred
TRIG LEVEL	Approximately centered
TRIG IN	±1V 10 kHz Square wave

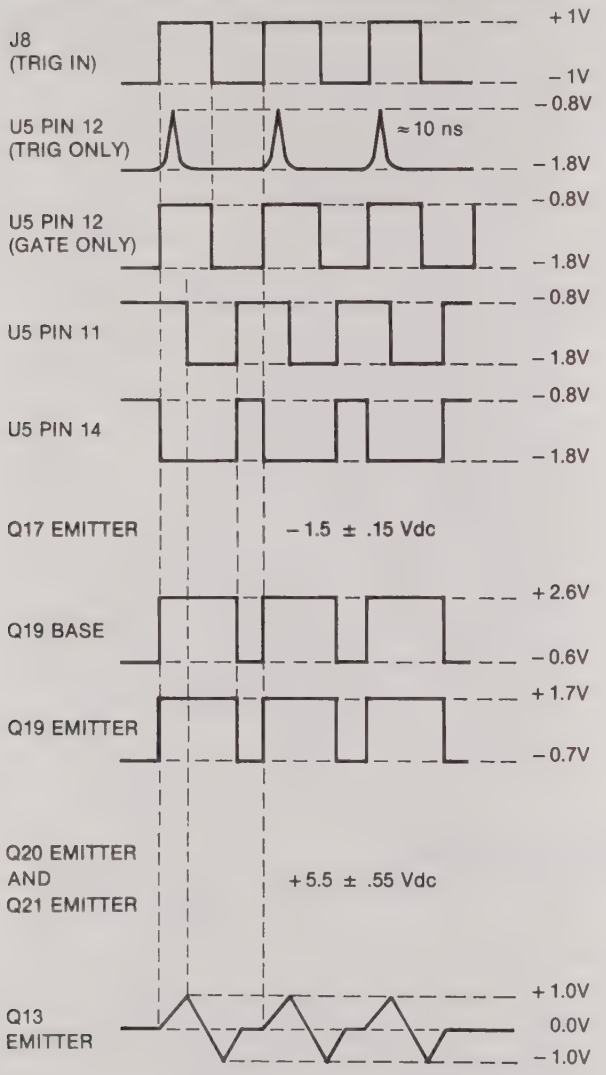


Figure 6-18. Trigger Baseline Waveforms

Continuous Mode Problems: Set the controls as shown; then take the waveform measurements. Refer to table 6-11.

Control	Setting
Frequency Dial	2.0
FREQ MULT	10K
SYM	Off
MODE	CONT

Table 6-11. Trigger Baseline Check (Continuous)

Test Point	Desired Results
U5 pin 12	−0.8 ± .08 Vdc
U5 pin 14	−1.8 ± .18 Vdc
Q17 emitter	−1.5 ± .15 Vdc
Q19 base	+2.6 ± .26 Vdc
Q19 emitter	+1.7 ± .17 Vdc
Q20 emitter	+5.5 ± .55 Vdc
Q21 emitter	+5.5 ± .55 Vdc
Q13 emitter	±1.0V triangle

6.4.12 Square Shaper Guide

Set the controls as shown; then perform the checks in table 6-12, and take waveform measurements. Refer to figure 6-19.

Control	Setting
Frequency Dial	2.0
FREQ MULT	1K
SYM	Off
MODE	CONT
FUNCTION	See Table 6-12 and Figure 6-19

Table 6-12. Square Shaper Checks

	Desired Results	
Test Point	Sine or Triangle	Square
Q22 emitter	−3.0 ± .3 Vdc	−3.0 ± .3 Vdc
U4 pin 13	−0.8 ± .08 Vdc	−4.3 ± .43 Vdc
Q26 base	−0.8 ± .08 Vdc	−4.2 ± .42 Vdc
Q26 emitter	−1.6 ± .16 Vdc	−4.0 ± .4 Vdc
CR24 anode	+1.6 ± .16 Vdc	−1.5 ± .15 Vdc

6.4.13 Sine Converter Guide

Set the controls as shown; then perform the checks in table 6-13 and take waveform measurements. Refer to figure 6-20.

Control	Setting
Frequency Dial	2.0
FREQ MULT	1K
SYM	Off
MODE	CONT
FUNCTION	Sine

Table 6-13. Sine Converter Checks

Test Point	Desired Results
Junction R170 and R171	+14.8 ± 1.5 Vdc
Junction R173 and R174	−14.8 ± 1.5 Vdc
U3 pin 2	0.0V (Full scale current = 2 mA

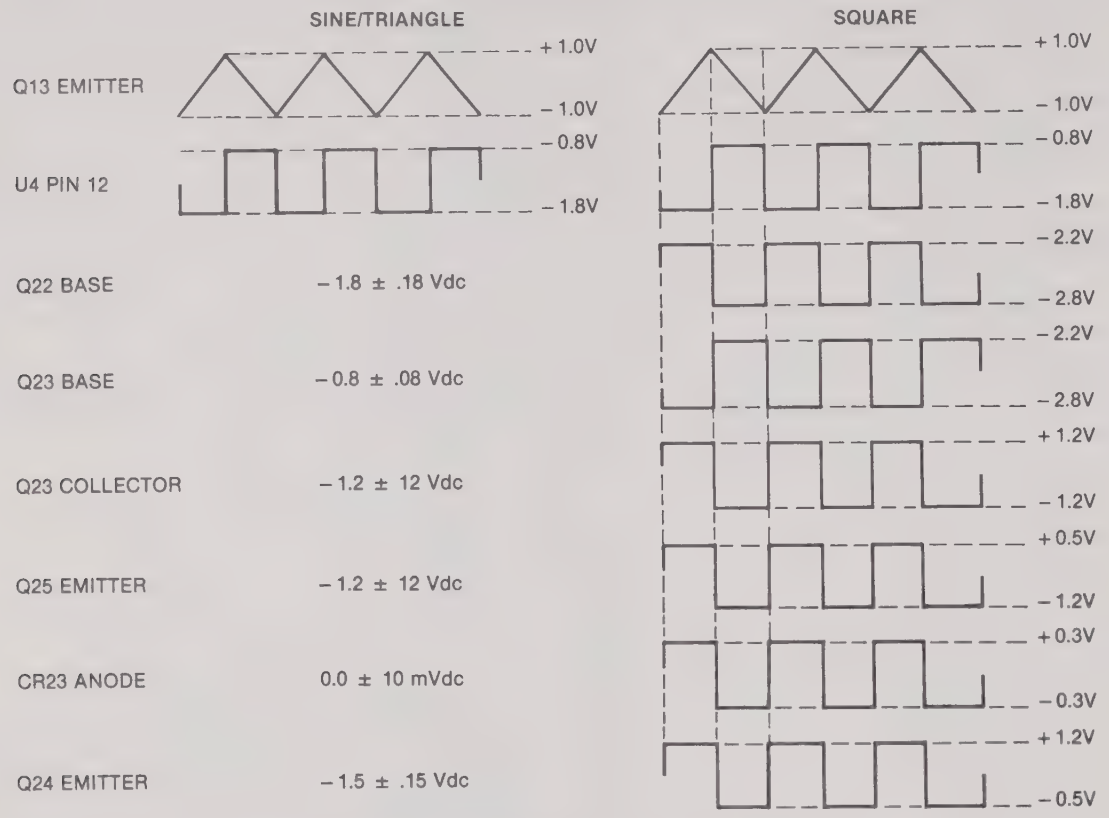


Figure 6-19. Square Shaper Waveforms

6.4.14 Preamplifier Guide

DC Problems: Set the FUNCTION control to DC; then perform the checks in table 6-14.

Table 6-14. Preamplifier Checks (DC)

Test Point	Desired Results
U1 pin 2	+14.86 ± 1.5 Vdc
U1 pin 3	−0.7 ± .07 Vdc
U1 pin 13	−1.4 ± .14 Vdc
U1 pin 9	−0.7 ± .07 Vdc
U1 pin 4	0.0 ± 10 mV
U1 pin 8	0.0 ± 10 mV
U1 pin 12	+5.8 ± .58 Vdc
U1 pin 11	+6.6 ± .66 Vdc
Q27 base	+9.6 ± .96 Vdc
Q27 emitter	+10.3 ± 1 Vdc
Q28 collector	+11.3 ± 1.1 Vdc

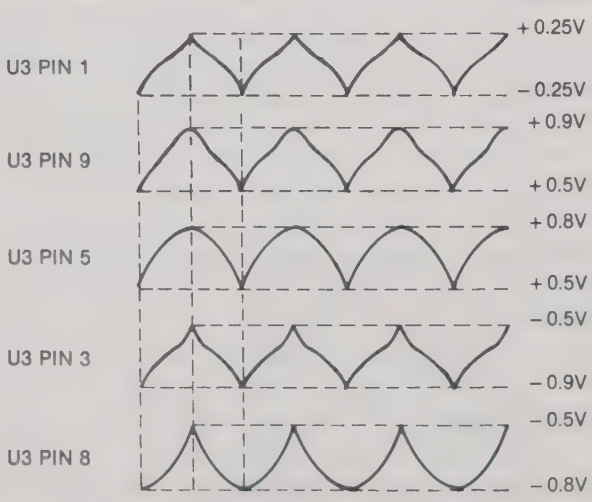


Figure 6-20. Sine Converter Waveforms

Function Problems: Set the controls as shown; then take the waveform measurements. Refer to figure 6-21.

Control	Setting
Frequency Dial	2.0
FREQ MULT	1K
SYM	Off
MODE	CONT
FUNCTION	Square

Figure 6-21. Preamplifier Waveforms

6.4.15 Output Amplifier Guide

Set the controls as shown; then take the waveform measurements. Refer to table 6-15.

Control	Setting
FUNCTION	DC
DC OFFSET	Off

6.5 TROUBLESHOOTING INDIVIDUAL COMPONENTS

6.5.1 Transistor

1. A transistor is defective if more than one volt is measured across its base-emitter junction in the forward direction.
2. A transistor when used as a switch may have a few volts reverse bias voltage across base emitter junction.
3. If the collector and emitter voltages are the same, but the base emitter voltage is less than 500 mV forward voltage (or reversed bias), the transistor is defective.
4. A transistor is defective if its base current is larger than 10% of its emitter current (calculate currents from voltage across the base and emitter series resistors).
5. In a transistor differential pair (common emitter stages), either their base voltages are the same in normal operating condition, or the one with less forward voltage across its base emitter junction should be off (no collector current); otherwise, one of the transistors is defective.

Table 6-15. Output Amplifier Checks

Test Point		Desired Results
	Base	+11.7 ± 1.2 Vdc
Q30	Emitter	+11 ± 1.1 Vdc
	Collector	+19 ± 1.9 Vdc
Q32	Collector	+22.8 ± 2.3 Vdc
	Base	−12 ± 1.2 Vdc
Q31	Emitter	−11.3 ± 1.1 Vdc
	Collector	−19 ± 1.9 Vdc
Q33	Collector	−22.7 ± 2.3 Vdc
Q36	Base	+18.3 ± 1.8 Vdc
	Emitter	+19 ± 1.9 Vdc
	Collector	+0.7 ± .07 Vdc
Q37	Emitter	+0.05 ± .003 Vdc
	Collector	+22.5 ± 2.3 Vdc
Q38	Emitter	+0.05 ± .005 Vdc
CR27	Cathode	+23 ± 2.3 Vdc
	Anode	+0.6 ± .06 Vdc
VR5	Input	+31 ± 3.1 Vdc
	Output	+24 ± 2.4 Vdc
Q34	Collector	+22.8 ± 2.3 Vdc
Q39	Base	−18.3 ± 1.8 Vdc
	Emitter	−19 ± 1.9 Vdc
	Collector	−0.05 ± .005 Vdc
Q40	Emitter	−0.05 ± .005 Vdc
	Collector	−21 ± 2.1 Vdc
Q41	Emitter	−0.05 ± .005 Vdc
CR28	Anode	−23 ± 2.3 Vdc
Q35	Base	−0.6 ± .06 Vdc
VR6	IN	−31 ± 3.1 Vdc
	ADJ	−21.3 ± 2.1 Vdc
	OUT	−23.6 ± 2.4 Vdc
U2	Pin 2	0.0 ± 10 mVdc
	Pin 6	−0.05 ± .005 Vdc

6.5.2 Diode

A diode (except a zener) is defective if there is greater than one volt (typically 0.7 volt) forward voltage across it.

6.5.3 Operational Amplifier

1. The "+" and "−" inputs of an operational amplifier will have less than 15 mV voltage difference when operating under normal conditions.
2. When the output of the amplifier is connected to the "−" input (voltage follower connection), the output should be the same voltage as the "+" input voltage; otherwise, the operational amplifier is defective.
3. If the output voltage stays at maximum positive, the "+" input voltage should be more positive than "−" input voltage, or vice versa; otherwise, the operational amplifier is defective.

6.5.4 FET Transistor

1. No gate current should be drawn by the gate of an FET transistor. If so, the transistor is defective.
2. The gate-to-source voltage is always reverse biased under a normal operating condition; e.g., the source voltage is more positive than the gate voltage for 2N5485, and the source voltage is more negative than gate voltage for a 2N5462. Otherwise, the FET is defective.
3. If the device supplying gate voltage to an FET saturates, the FET has too large a Vgs (pinch off) for the circuit and should be replaced.

6.5.5 Capacitor

1. Shorted capacitors have 0V across their terminals.
2. Opened capacitor can be located (but not always) by using a good capacitor connected in parallel with the capacitor under test and observing the resulting effect.
3. Leaky capacitors will often have a decreased voltage across their terminals.

6.5.6 Digital ECL ICs

1. The device is operating correctly if the output high state is −0.81 to −0.96V and low state is −1.65 to −1.85V.
2. The input must show the same two levels as in step 1.

SECTION 7
PARTS AND SCHEMATICS

7.1 DRAWINGS

The following assembly drawings (with parts lists) and schematics are in the arrangement shown below.

7.2 ADDENDA

Under Wavetek's product improvement program, the latest electronic designs and circuits are incorporated into each WAvetek instrument as quickly as development and testing permit. Because of the time needed to compose and print instruction manuals, it is not always possible to include the most recent changes in the initial printing. Whenever this occurs, addendum pages are prepared to sumarize the changes made and are inserted immediately inside the rear cover. If no such pages exist, the manual is correct as printed.

7.3 ORDERING PARTS

When ordering spare parts, please specify part number, circuit reference, board, serial number of unit, and, if applicable, the function performed.

NOTE

An assembly drawing number is not necessarily the assembly part number. However, the assembly parts list number is the assembly part number.

DRAWING	DRAWING NUMBER
Instrument Schematic	0004-00-0167
Chassis Assembly	0102-00-0838
Chassis Parts Lists	1101-00-0838
Generator Board Schematic	0103-00-0834
Generator Board Assembly	1100-00-0834
Generator Board Parts List	1100-00-0834
Generator Board Switch Detent	0102-00-0958
Generator Board Switch Parts List	1202-00-0958
Rear Panel Assembly	0102-00-0957
Rear Panel Parts List	1101-00-0957
Front Panel Assembly	0102-00-0980
Front Panel Parts List	1101-00-0980

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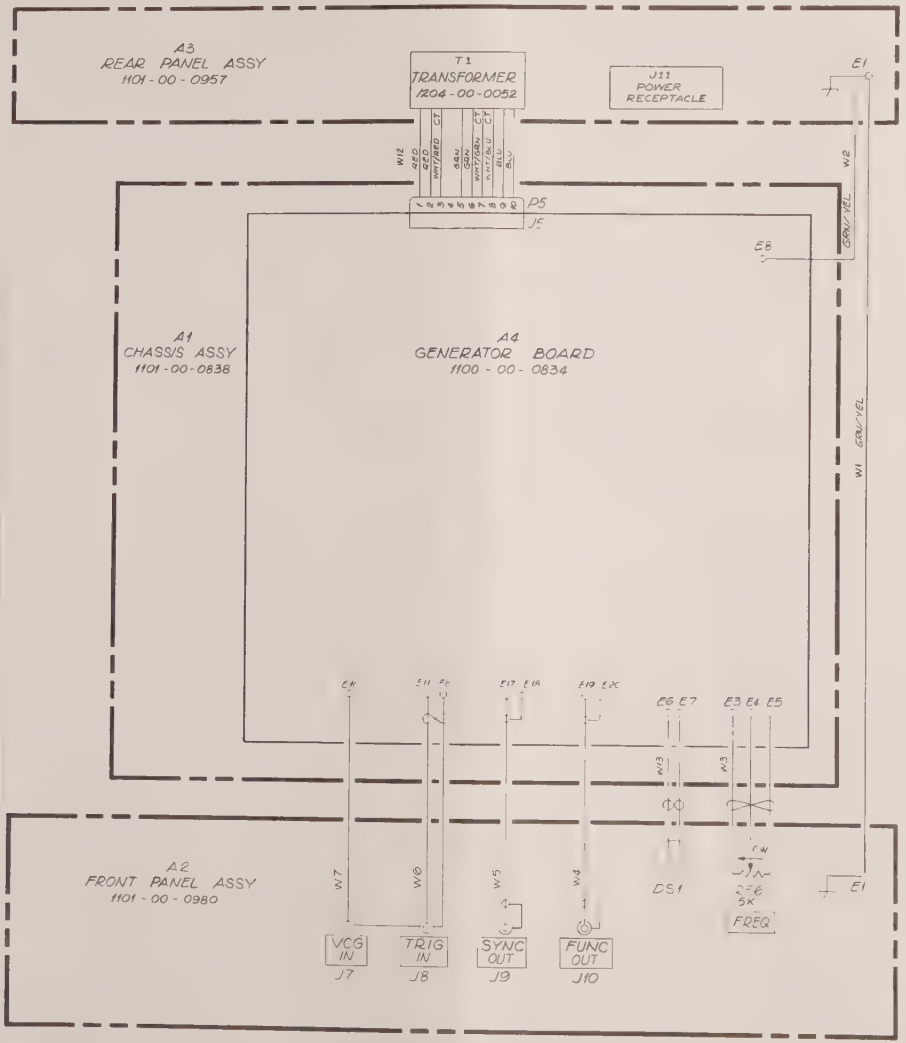

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES
MATERIAL
FINISH WAVETEK PROCESS
DRAWN
PROJENGR
RELEASE APPROV
TOLERANCE UNLESS OTHERWISE SPECIFIED
DO NOT SCALE DWG
SCALE
DATE 3/31/81

WAVETEK
TITLE SCHEMATIC INSTRUMENT
MODEL NO 190
DWG NO
REV
CODE IDENT 23338
SHEET OF

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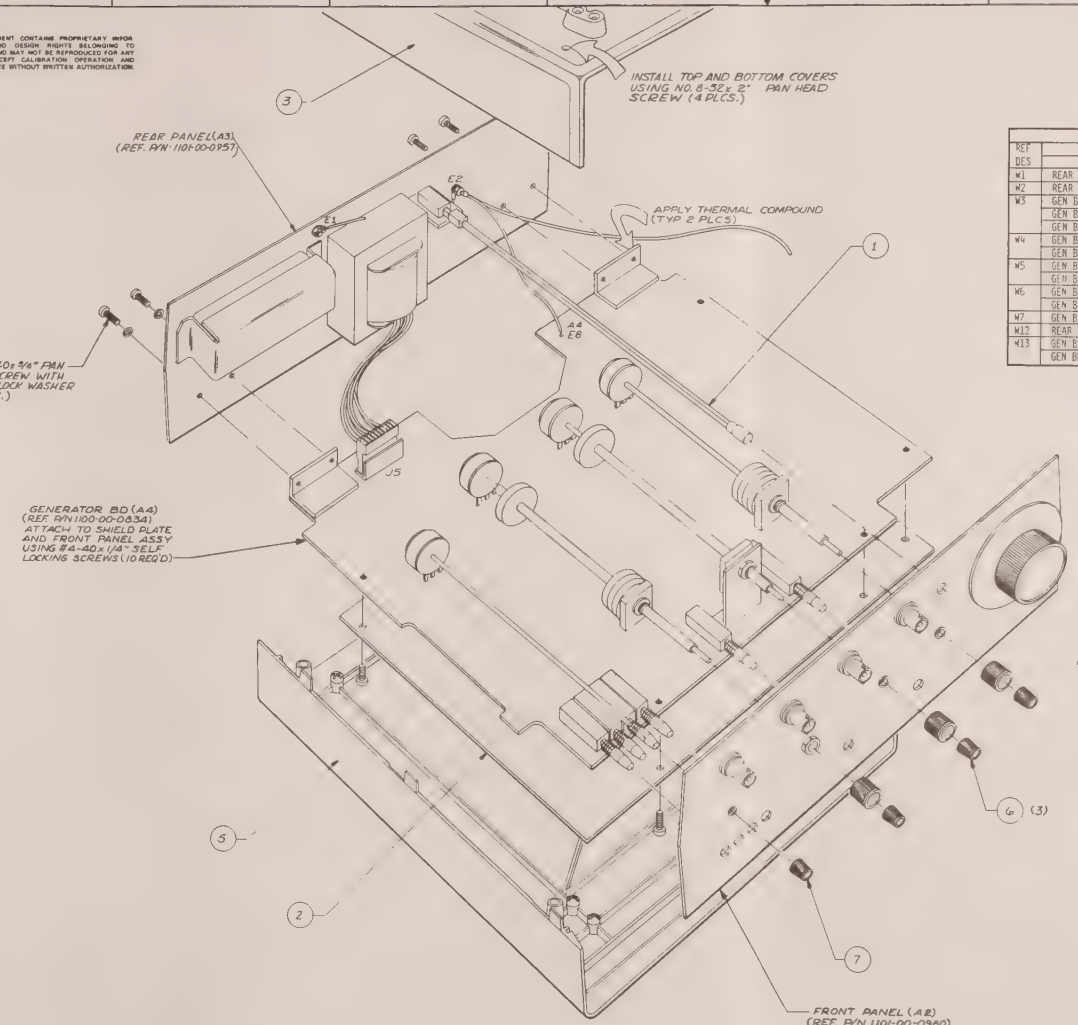
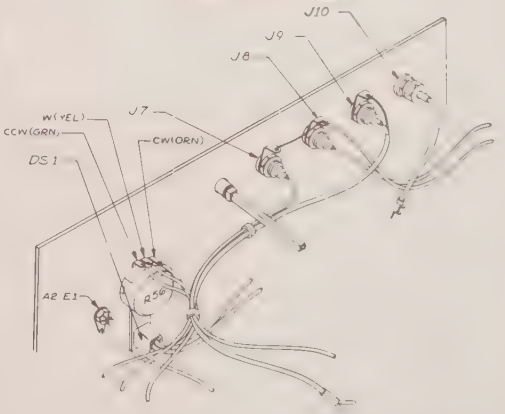
REV	ECN	BY	DATE	APP


INSTALL TOP AND BOTTOM COVERS USING NO. 8-32 x 2" PAN HEAD SCREW (4 PLCS.)
REAR PANEL (A3) (REF. P/N 1101-00-0957)
APPLY THERMAL COMPOUND (TYP 2 PLCS)
NO. 4-40 x 3/8" PAN HEAD SCREW WITH SPLIT LOCK WASHER (4 PLCS.)
GENERATOR BD (A4) (REF. P/N 1100-00-0834) ATTACH TO SHIELD PLATE AND FRONT PANEL ASSY USING #4-40 x 1/4" SELF LOCKING SCREWS (10 REQ'D)
FRONT PANEL (A2) (REF. P/N 1101-00-0980)
J5
E1
E2
A4 E8
(3)

CHASSIS ASSEMBLY WIRE & CABLE HOOK-UP			
REF DES	DESTINATION FROM	TO	COLOR
W1	REAR PANEL - A3 E1	FRONT PANEL - A2 E1	GRN/YEL
W2	REAR PANEL - A3 E3	FRONT PANEL - A4 E8	GRN/YEL
W3	GEN BD - E3	FRONT PANEL - R56-CW	ORN
	GEN BD - E4	FRONT PANEL - R56-W	YEL
	GEN BD - E5	FRONT PANEL - R56-CCW	GRN
W4	GEN BD - E19	FRONT PANEL - J10	BLK
	GEN BD - E20 ⏚	FRONT PANEL - J10 ⏚	
W5	GEN BD - E17	FRONT PANEL - J9	BLK
	GEN BD - E18 ⏚	FRONT PANEL - J9 ⏚	
W6	GEN BD - E11	FRONT PANEL - J8	WHT/BRN
	GEN BD - E21 ⏚	FRONT PANEL - J8 ⏚	BLK
W7	GEN BD - E10	FRONT PANEL - J7	WHT/BLK
W12	REAR PANEL - A3	GEN BD - J5	N/A
W13	GEN BD - A4 E6	FRONT PANEL - DS1	N/A
	GEN BD - A4 E7	FRONT PANEL - DS1	N/A

FRONT PANEL WIRING AND ROUTING



1 SEE PARTS LIST NO: 1101-00-0838.

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN J.D COOPER	DATE 1582	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJENGR		TITLE ASSEMBLY CHASSIS (A1)
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES ± 1 XX ± .030		
	DO NOT SCALE DWG		MODEL NO 190
	SCALE		DWG NO 0102-00-0838 REV
		CODE IDENT 23330	SHEET 1 OF 1

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	DRIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
NONE	ASSY DRWG CHASSIS	0102-00-0838	WVTK	0102-00-0838	1
1	ASSY POWER ROD	190-0956	WVTK	1206-00-0956	1
5	ASSY TOP COVER	1206-00-1013	WVTK	1206-00-1013	1
3	ASSY BOTTOM COVER	1206-00-1014	WVTK	1206-00-1014	1
NONE	CHASSIS CABLE KIT	190-0959	WVTK	1207-00-0959	.
2	SHIELD PLATE	1400-01-3843	WVTK	1400-01-3843	1
6	COAX KNOB SET	RB-67-1-SB+C-M-9	ROGAN	2400-01-0009	3
-	KNOB SMALL	C-M-9	ROGAN	2400-01-0010	1

WAVETEK PARTS LIST	TITLE ASSY CHASSIS	ASSEMBLY NO 1101-00-0838	REV
		PAGE 1	

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJ ENGR		TITLE PARTS LIST CHASSIS
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED .XXX ± .010 ANGLES ± 1° .XX ± .030		MODEL NO 190 / DWG NO 1101-00-0838 / REV
	DO NOT SCALE DRWG		CODE IDENT 23338 / SHEET 1 OF 1
	SCALE		

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REV	ECN	BY	DATE	APP
A	3556, 3557, 3598 3527, 3528, 3599			

POWER SWITCH (A3-SW1)

REAR PANEL (A3)

WIRE COLOR	190	191	193
BLU	15.4	16.4	5.8
GRN	6.8	8.4	7.2
RED	25.4	24.1	24.1

A3-E2 — BLK, RED, GRN, WHT

HOT, GND, NEUT

F1 1/2A S.B. 115V 1/4A S.B. 230V

POWER RECEPTACLE
190 - J11
191 - J13
193 - J15

BLK, ORN, WHT/BLK, GRY, WHT/GRY

T1

BLU, WHT/BLU, GRN, WHT/GRN, RED, WHT/RED

VR1 LM317T — +21.5 — C1 .1 — +15V — R1 121 — C2 25 — R2 1.21K — +15 BAL — R3 200 — R4 1.21K — R5 121

VR2 LM337T — C3 1000, 50V — C4 1000, 50V — C5 .1 — C6 25 — -21.5

VR3 LM78C5CT — +11.3 — C7 2200, 16V — C8 .1 — C9 6800, 16V — C10 .1 — C11 100, 16V

VR4 LM7905CT — C12 100, 16V — C20 .1

CR1 3N254 — CR2 3N254 — CR3 3N254

C13 1000, 50V — C14 1000, 50V — +31 — -31

J5-C AC, J5-B AC, J5-E CT, J5-A AC, J5-1 CT, J5-F AC, J5-4 AC, J5-5 AC, J5-* AC, J5-1 AL, CT

J1-7, J1-16, J1-15, J1-5, J1-4, J1-14, J3-10, J3-11

E6, E7 — (A2) FRONT PANEL DS1 L6/50

TP5, TP6, TP7

FRONT PANEL A2 — A2-E1 — A3-E1 — E8 — RV1 V56ZA8

FRONT PANEL MODEL 191 ONLY (A2)
PULSE SYNC OUT J11 — E15 J4-3 — E16 J4-4
PULSE/SQUARE OUT J12 — E13 J4-1 — E14 J4-2

FRONT PANEL MODEL 193 ONLY (A2)
AM IN J14 — E15 J4-3 — E12 J4-4
AUX OUT J13 — E13 J4-1 — E14 J4-2

C119 .1 — C120 .1 — C121 1 — C122 1

17. * NOMINAL VALUE- CALLED OUT ON PARTS LIST.
16. .1 TO 10K RANGES ONLY (2 PLCS.)
15. USED ON 190 ONLY (1 PLC)
14. USED ON 192 ONLY.
13. NOT USED ON 193
12. NOT USED ON 191
11. NOT USED ON MODEL 192 (3 PLCS).
10. MODEL 193 ONLY (5 PLCS)
9. MODEL 191 ONLY (10 PLCS)
8. SELECTED 2N3866 FOR V_{CEO} @ 40V (3 PLCS)
7. P/N 4807-02-0777 (MATCHED PAIR FD777)
6. VOLTS AC WITH: V_{LINE} RMS 115, CORCOM TAB = 120
5. SIP'S ARE: R12 = 470, R24 = 680, R124 = 680.
4. ALL DIODES ARE FD6666
3. ALL CAPACITORS ARE IN MICROFARADS.
2. ALL RESISTORS ARE 1/8W AND ARE IN OHMS.
1. PARTIAL REFERENCE DESIGNATORS SHOWN. USE ASSEMBLY REF. DES. PREFIX A4 (EXAMPLE A4R1)

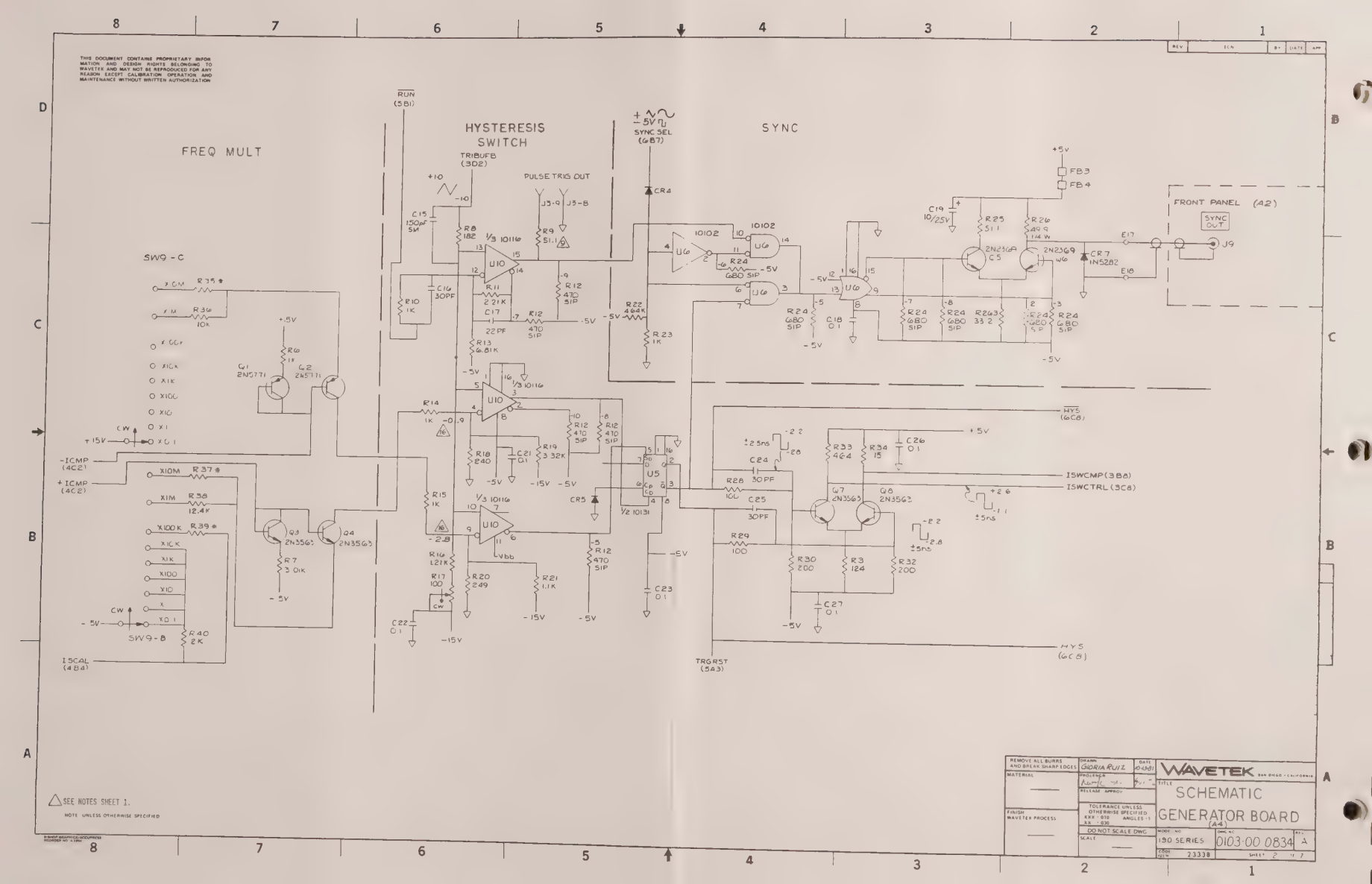
NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES — MATERIAL — FINISH WAVETEK PROCESS — DRAWN GLORIA RUIZ — DATE 10/13/81 — TOLERANCE UNLESS OTHERWISE SPECIFIED .XX .010 .XXX .005 ANGLES 1° — DO NOT SCALE DWG — SCALE —

WAVETEK

TITLE: SCHEMATIC GENERATOR BOARD (A4)

MODEL NO 190 SERIES — DWG NO 0103.00.0834 — REV A — CODE NO 33338 — SHEET 1 OF 7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REV
ECN
BY
DATE
APP
FREQ MULT
HYSTERESIS SWITCH
SYNC
RUN (5B1)
TRIBUFB (3D2)
PULSE TRIG OUT
J3-9
J3-8
SYNC SEL (6B7)
CR4
FRONT PANEL (A2)
SYNC OUT
J9
FB3
FB4
SW9-C
SW9-B
SW9-A
CW
+15V
-15V
-5V
+5V
-ICMP (4C2)
+ICMP (4C2)
ISCAL (4B4)
HYS (6C8)
ISWCMP (3B8)
ISWCTRL (3C8)
TRGRST (5A3)
SEE NOTES SHEET 1.
NOTE UNLESS OTHERWISE SPECIFIED
REMOVE ALL BURRS AND BREAK SHARP EDGES
MATERIAL
FINISH WAVETEK PROCESS
DRAWN GLORIA RUIZ
DATE 10-6-81
TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 XX ± .030 ANGLES ± 1°
DO NOT SCALE DWG.
SCALE
WAVETEK SAN DIEGO, CALIFORNIA
TITLE SCHEMATIC GENERATOR BOARD (A4)
MODEL NO 190 SERIES
DWG NO 0103-00 0834
REV A
CODE IDENT NO 23338
SHEET 2 OF 7

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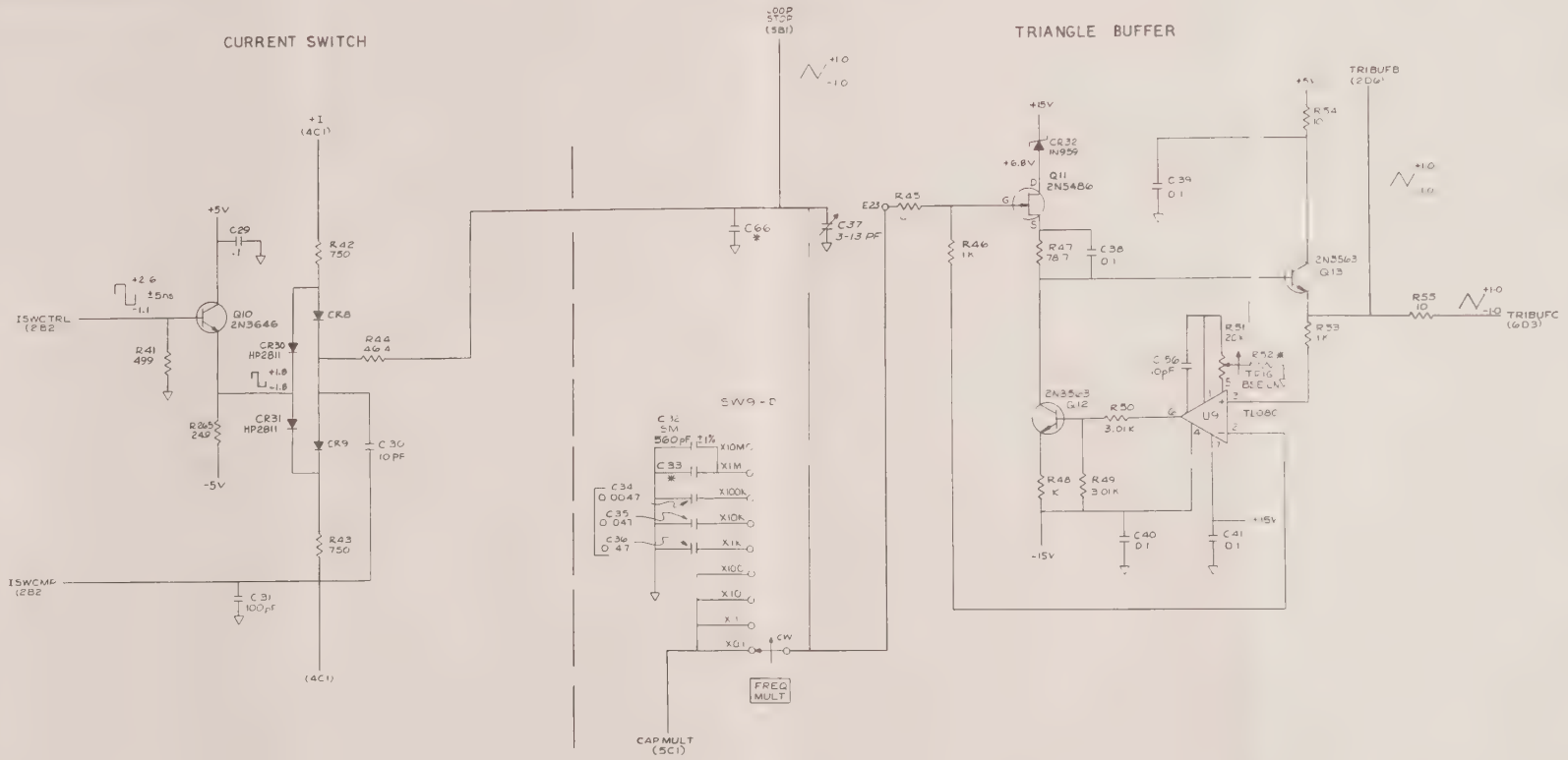

△SEE NOTES SHEET 1

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN GLORIA RUIZ	DATE 10-31	WAVETEK SAN DIEGO, CA.
MATERIAL	PROJENGR		TITLE SCHEMATIC GENERATOR BOARD (A4)
FINISH WAVETEK PROCESS	RELEASE APPROV		
	TOLERANCE UNLESS OTHERWISE SPECIFIED .XX ± .010 .XXX ± .005 ANGLES ± 1°		
	DO NOT SCALE DWG		MODEL NO 190 SERIES
	SCALE		DWG NO 0103-00-0834 REV A
			CODE IDENT 23338 SHEET 3 OF 7

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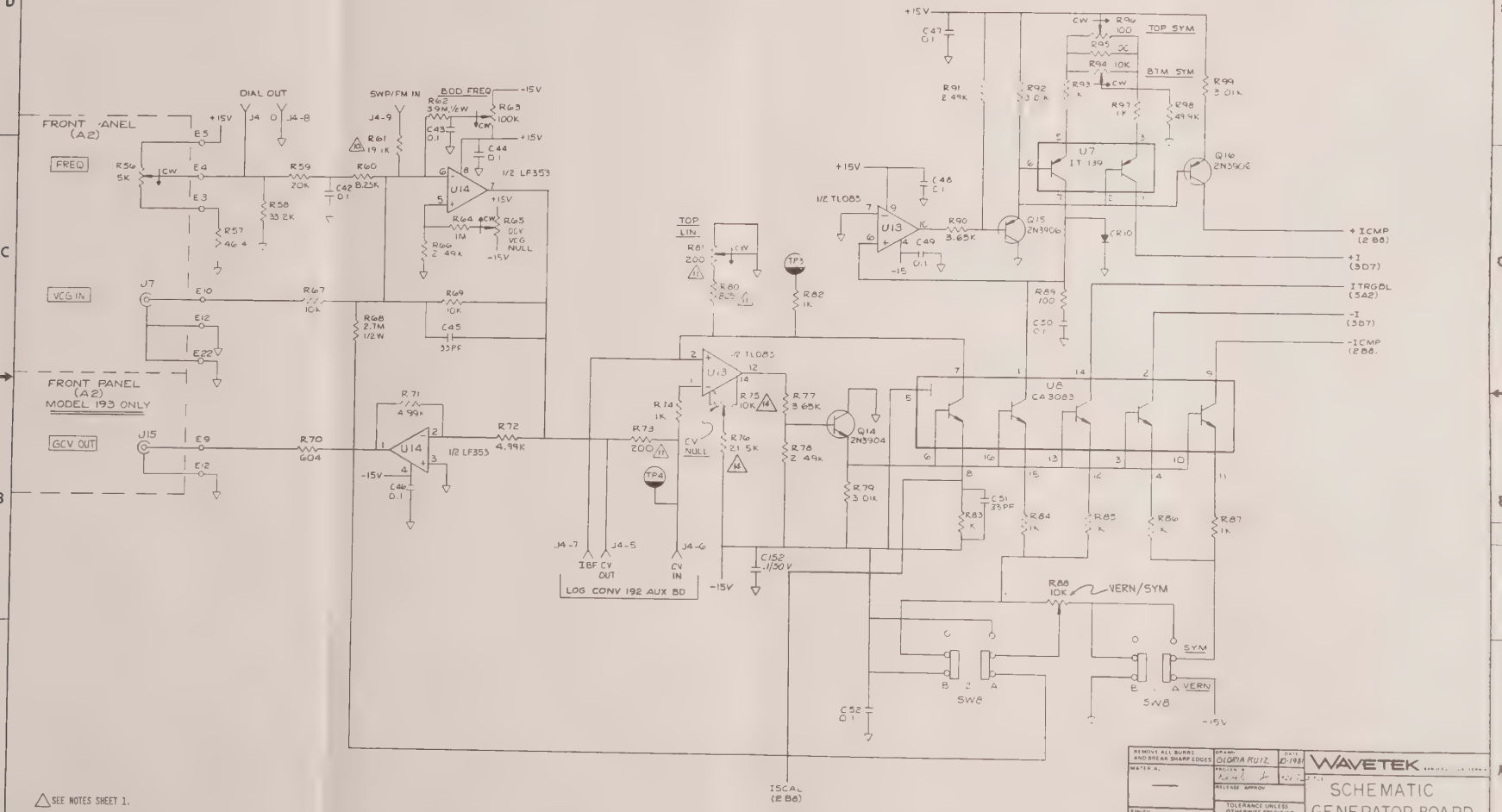
CURRENT SOURCES



REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN: GLORIA RUIZ	DATE: 10-1981	WAVETEK
MATERIAL	ENGINEER		SCHEMATIC GENERATOR BOARD (A4)
FINISH: WAVETEK PROCESS	RELEASE APPROV.		
	TOLERANCE UNLESS OTHERWISE SPECIFIED: XXX ±.010 ANGLES ±1° XX ±.030		MODEL NO: 190 SERIES
	DO NOT SCALE DWG		DWG NO: 0103-00-0834 REV: A
	SCALE		CODE IDENT: 23338 SHEET 4 OF 7

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FREQ MULT SW9-A

CAPACITANCE MULTIPLIER

CAP MULT FREQ

R102 2K
R100 4.99K
R101 909
½ TL083 U11
+15V C53 0.1
-15V C54 0.1
R103 100
C55 0.1 10% POLYE
R104 10
X10M X1M X100K X10K X1K
R108 9.09K X100
R110 100K X10
R111 1M X1
R112 10M X0.1
R113 10
E1 E2
½ TL083 U11
R106 10K CAP MULT ZERO
R107 24.9K
R105 4.99K
-15V
R114 1.5K
C56 0.005
C57 0.47 1% POLYC 50V
+1.10 -1.0
CAP MULT (3A5)

TRIGGER

SW6 MAN TRIG
CR11
⅓ 10116 U12
R115 681 -5V
VBB -1.3
R116 681 -5V
C58 0.1
-5V

TRIG IN J8
E11 E12 E21
C59 1.5 pF
R117 1.5K
(A2) FRONT PANEL
CR12 CR13
C60 30PF
R120 499
R118 3.01K
R121 1K
R122 681
+15V
TRIG LVL R119 10K
-15V
C61 0.1
R123 681
-5V
R124 680 SIP -2
-5V

SW7
CF TF GF CB TB GB
J2-8 J2-7 J2-6 J2-5 J2-4 J2-3
ALWAYS LOAD CR16
GATE OUT GATE IN
J3-1 J3-2 J3-3
CR14 CR15 CR17
CCW CW
MODE
¼ 10102 U4
R126 221
R127 51
R128 51
R124 680 SIP -7
C63 0.1 5V
32 PF
R124 680 SIP -6
R125 1K
R124 680 SIP -8
-5V

TRIG BASELINE

½ 10131 U5
N/C
RUN (2D6)
C64 0.1
R129 499
R130 1K
Q19 2N3563
Q17 Q18 2N3563
R131 464K
CR18 FD 111
CR19 FD777
+1.0 -1.0 LOOP STOP (3D4)
R133 1K
R132 392
R12 470 SIP -4
R12 470 SIP -3
Q20 2N3906
R134 1K
Q21 2N3906
C65 0
ITRGBL (4C1)
-15V
TRIG RST (2A4)
-1.8

△ SEE NOTES SHEET 1.
NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES
MATERIAL —
FINISH WAVETEK PROCESS
DRAWN J SHOPPER
PROJ ENG —
RELEASE APPROV
TOLERANCE UNLESS OTHERWISE SPECIFIED .XX ±.010 ANGLES ±1 .XX ±.030
DO NOT SCALE DWG
SCALE —

WAVETEK SAN DIEGO, CALIFORNIA
TITLE SCHEMATIC GENERATOR BOARD (A4)
MODEL NO 190 SERIES
DWG NO 0103 00 0834 REV A
SIZE D 23338
SHEET 5 OF —

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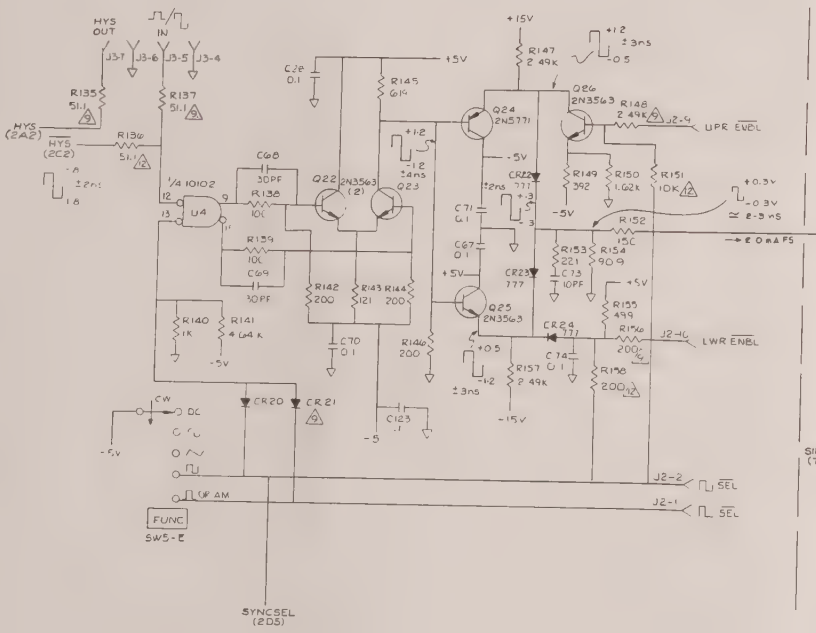
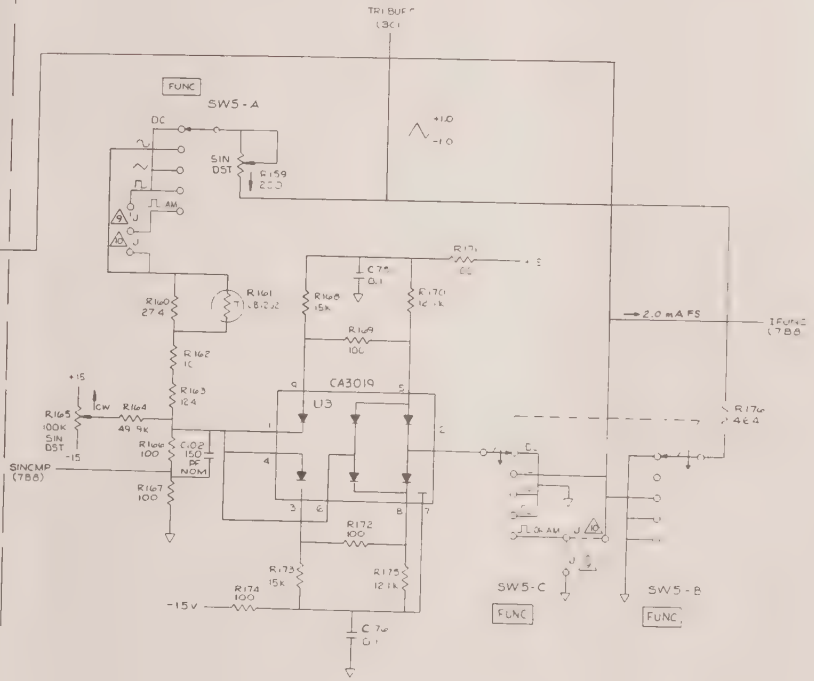
SQUARE SHAPER



SINE CONVERTER



△SEE NOTES SHEET 1.

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN GLORIA RUIZ	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL —	RELEASE APPROV	SCHEMATIC GENERATOR BOARD (2-3)
FINISH WAVETEK PROCESS —	TOLERANCE UNLESS OTHERWISE SPECIFIED .XX ±.010 .XXX ±.005 ANGLES ± 1°	190 SERIES 0163 00 0834 A
	DO NOT SCALE DWG	SIZE D 23338 SHEET 2 OF 3

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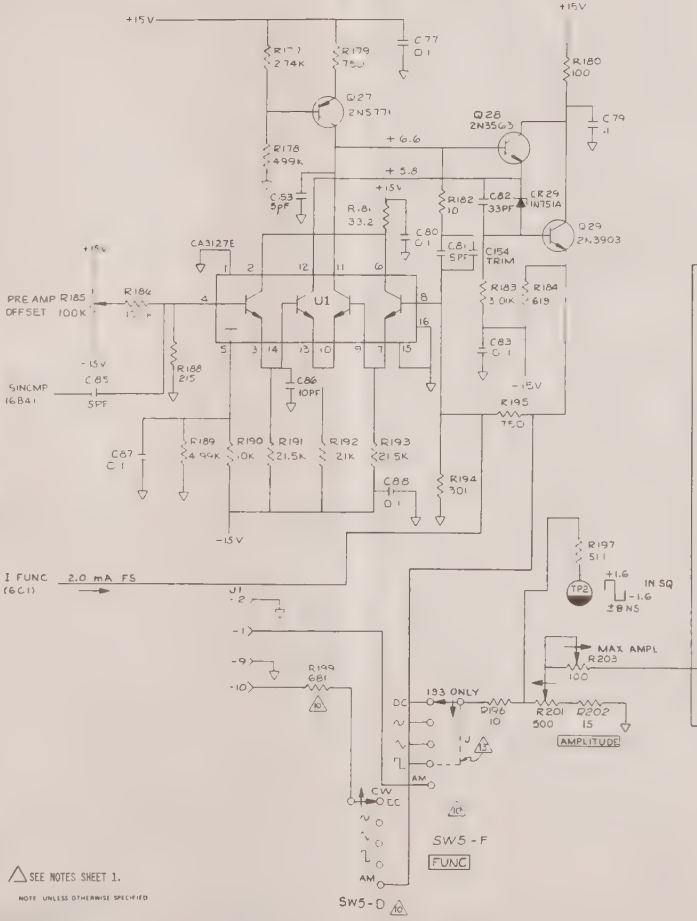
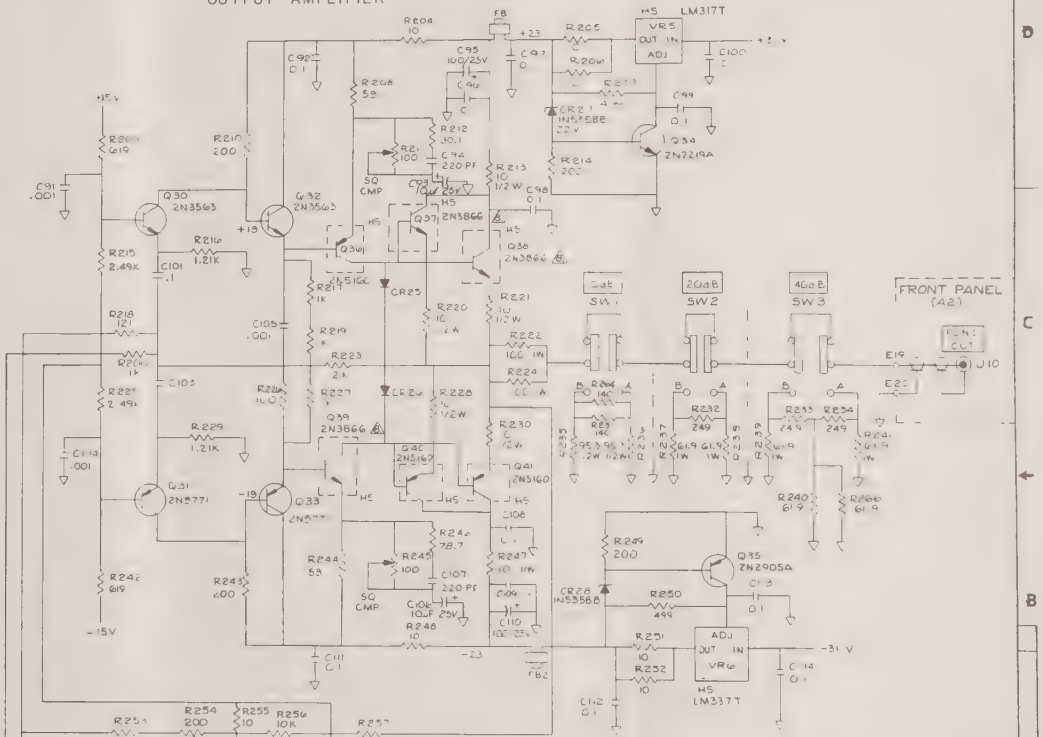
PREAMPLIFIER



OUTPUT AMPLIFIER



REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	CLAUDIA RUIZ	DATE	WAVETEK SAN DIEGO, CALIFORNIA	
MATER'L	PROJECT			SCHEMATIC	
FIN SH WAVETEK PROCESS	RELEASE APPROV.			GENERATOR BOARD (A4)	
	TOLERANCE UNLESS OTHERWISE SPEC'D: XX .010 ANGLES ± XX .020				
	DO NOT SCALE DWG			MODEL NO. 190 SERIES	DWG NO. 0103 00 0834 REV. A
	SCALE			CODE IDENT. NO. 23378	SHEET 7 OF 7

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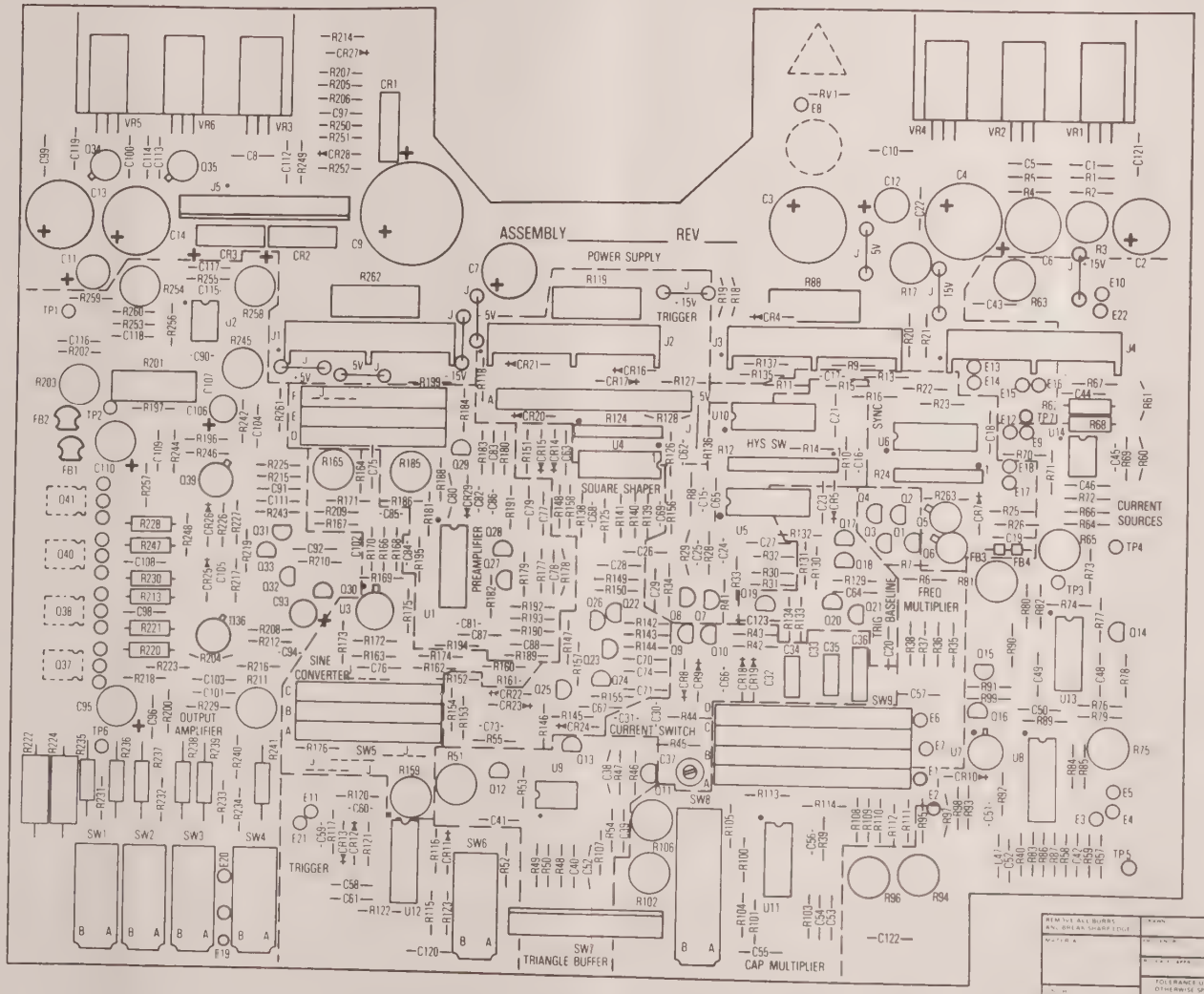


WAVETEK			
GENERATOR BOARD			
SIZE 190	1100-00-0834	REV	
23338		SHEET 1 OF 1	

REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
NONE	ASSY DRWG.GENERATOR	0101-00-0834	WVTK	0101-00-0834	1
NONE	SCHEMATIC.GENERATOR	0103-00-0834	WVTK	0103-00-0834	1
NONE	ASSY.GENERATOR SWITCHES	190-0958	WVTK	1202-00-0958	1
NONE	ASSY.REGISTER MNTG BRACKET	190-0996	WVTK	1206-00-0996	1
NONE	ASSY BOARD MNTG ANGLE	190-1024	WVTK	1206-00-1024	1
NONE	BRKT	133-305	WVTK	1400-00-1673	1
C153 C667 C81 C85	CAP.CER.,3PF,1KV	DD-030	CRL	1500-00-5013	4
C156	CAP.CER.10PF 1KV	DD-100LL	CRL	1500-01-0001	1
C30 C73 C86	CAP CER 10PF 1KV	DD-100	CRL	1500-01-0011	3
C31	CAP.CER.100PF.1KV	DD-101	CRL	1500-01-0111	1
C104 C105 C91	CAP.CER.,.001MF.1KV	DD-102	CRL	1500-01-0211	3
C1 C10 C100 C101 C103 C108 C109 C111 C112 C113 C114 C116 C117 C118 C119 C120 C121 C122 C152 C18 C20 C21 C22 C23 C26 C27 C28 C29 C38 C39 C40 C41 C42 C43 C44 C46 C47 C48 C49 C5 C50 C52	CAP.CER.MON..,1MF.50V	CAC0375U1047050A	CORNG	1500-01-0405	68

WAVETEK PARTS LIST — TITLE: PCA GENERATOR — ASSEMBLY NO: 1100-00-0834 — REV: A — PAGE 1

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
	RADIAL LEAD. SP .20				
C11 C12	CAP ELECT 100MF/16V RADIAL LEAD. SP .20	CRE SERIES 100/16	CAPAR	1500-31-0111	2
C13 C14 C3 C4	CAP ELECT.1000MF/50V RADIAL LEAD SP .70	CRE SERIES 1000/50	CAPAR	1500-31-0203	4
C7	CAP ELECT 2200MF 16V RADIAL LEAD SP .30	CRE SERIES 2200/16	CAPAR	1500-32-2201	1
C9	CAP.ELECT 6800MF 16V RADIAL LEAD. SP .50	CRE SERIES 6800/16	CAPAR	1500-36-8201	1
C55	CAP.MYLAR.,.1MF.100V	225P10491WD3	SPRAG	1500-41-0444	1
C34	CAP MYLR..0047MF 50V	C5R472F	ELPAC	1500-44-7203	1
C35	CAP.MYLR..047MF 50V	C5R473F	ELPAC	1500-44-7303	1
C36 C57	CAP MYLR..47MF.50V	C5R474F	ELPAC	1500-44-7403	2
C37	VARI 3.5-13PF 250V	7S-TRIKO-02 3.5/13PF	TRIKO	1500-51-3000	1
NONE	GENERATOR BOARD	1700-00-0834	WVTK	1700-00-0834	1
J5	HEADER	1-640386-0	AMP	2100-02-0079	1
NONE	PIN SOCKET	SBA-20-S-TC	ROBIN	2100-03-0065	2
NONE	COAX BRAID TERMINATION	226176-4	AMP	2100-04-0037	1
NONE	TERM	200081	JSECO	2100-05-0009	28

WAVETEK PARTS LIST — TITLE: PCA GENERATOR — ASSEMBLY NO: 1100-00-0834 — REV: A — PAGE 3

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
R230 R247					
R66	RES.C.1/2W.5%.2.7M	RC200F275	STKPL	4700-25-2704	1
R62	RES.C.1/2W.5%.3.9M	RC200F-395	STKPL	4700-25-3904	1
R103 R138 R149 R166 R167 R169 R171 R172 R174 R180 R226 R28 R29 R89 R95	RES.MF 1/8W.1%.100	RN55D-1000F	TRW	4701-03-1000	15
R10 R121 R125 R130 R133 R134 R14 R140 R15 R200 R217 R219 R227 R23 R46 R48 R53 R6 R74 R82 R83 R84 R85 R86 R87 R93 R97	RES.MF 1/8W.1%.1K	RN55D-1001F	TRW	4701-03-1001	27
R151 R190 R236 R257 R260 R267 R67 R69	RES.MF 1/8W.1%.10K	RN55D-1002F	TRW	4701-03-1002	8
R110 R186	RES.MF.1/8W.1%.100K	RN55D-1003F	TRW	4701-03-1003	2
R111 R52T R64	RES.MF.1/8W.1%.1M	RN55D-1004F	TRW	4701-03-1004	3
R104 R113 R162 R182 R196 R204 R205 R206 R248 R251 R252 R255 R45 R54 R55	RES.MF.1/8W.1%.10	RN55D-10R0F	TRW	4701-03-1009	15
R21	RES.MF.1/8W.1%.1.1K	RN55D-1101F	TRW	4701-03-1101	1
R1 R142 R218 R5	RES.MF.1/8W.1%.121	RN55D-1210F	TRW	4701-03-1210	4
R16 R192 R2 R216 R229	RES.MF.1/8W.1%.1.21K	RN55D-1211F	TRW	4701-03-1211	5

WAVETEK PARTS LIST — TITLE: PCA GENERATOR — ASSEMBLY NO: 1100-00-0834 — REV: A — PAGE 5

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
C53 C54 C58 C61 C63 C64 C65 C67 C70 C71 C72 C74 C75 C76 C77 C79 C80 C83 C87 C88 C92 C96 C97 C98 C99					
C102F	CAP.CER.150PF 1KV	DD-151	CRL	1500-01-5111	1
C39	CAP.CER.1.5PF.1KV	10TCC-V15	SPRAG	1500-01-5907	1
C17	CAP.CER 22PF 1KV	DD-220	CRL	1500-02-2011	1
C107 C94	CAP.CER 220PF.1KV	DD-221	CRL	1500-02-2111	2
C16 C24 C25 C60 C68 C69	CAP.CER.30PF.1KV	DD-300	CRL	1500-03-0001	6
C45 C51 C62 C82	CAP.CER.33PF.1KV	DD-330	CRL	1500-03-3011	4
C56	CAP.CER.,.003MF.50V	CK-502	CRL	1500-05-0210	1
C115	CAP.CER.56PF.1KV	DD-5615LL	CRL	1500-05-6101	1
C15	CAP.MICA.150PF.500V	DM15-151J	ARCO	1500-11-5100	1
C33T	CAP.MICA.56PF.500V	DM15-560J	ARCO	1500-15-6000	1
C32	CAP.MICA.560PF.300V	CD15FC561F03	CDE	1500-15-6102	1
C10a C19 C93	CAP.ELECT.10MF/25V RADIAL LEAD. SP .10	CRE SERIES 10/25	CAPAR	1500-31-0002	3
C110 C2 C6 C95	CAP.ELECT.100MF.25V	CRE SERIES 100/25	CAPAR	1500-31-0102	4

WAVETEK PARTS LIST — TITLE: PCA GENERATOR — ASSEMBLY NO: 1100-00-0834 — REV: A — PAGE 2

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
TP1 TP2 TP3 TP4 TP5 TP6 TP7	BUSS BAR STANDOFF	2110-001	ARTWR	2100-05-0024	7
NONE	STANDOFF.SHADE .187HX.250 HEX 6-40,.062 MAT'L	6926-3/16-2C	LNTRN	2800-05-0004	6
NONE	TRANSIPAD	10123N	METRS	2800-11-0003	2
NONE	TRANSIPAD	10160	METRS	2800-11-0004	2
NONE	HEATSINK	209	WAKE	2800-11-0008	2
FB1 FB4	FERRITE BEAD	56-590-65/3B	FERRX	3100-00-0001	2
FB1 FB2	BALUN CORE	2873000902	FAIRT	3100-00-0002	2
R17 R203 R211 R245 R96	POT.TRIM.100	91AR100	BECK	4600-01-0103	5
R116 R94	POT.TRIM.10K	91AR10K	BECK	4600-01-0313	2
R165 R185 R63 R65	POT.TRIM.100K	91AR100K	BECK	4600-01-0402	4
R159 R254 R3 R81	POT.TRIM.200	91AR200	BECK	4600-02-0101	4
R192	POT.TRIM.2K	91AR2K	BECK	4600-02-0201	1
R258 R31	POT.TRIM.20K	91AR20K	BECK	4600-02-0301	2
R201	POT.CONT.500 FROM 4600-05-0105	4609-75-0106	WVTK	4609-75-0106	1
R213 R220 R221 R228	RES.C.1/2W.5%.10	RC200F-100	STKPL	4700-25-0100	6

WAVETEK PARTS LIST — TITLE: PCA GENERATOR — ASSEMBLY NO: 1100-00-0834 — REV: A — PAGE 4

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
R253 P4					
R170 R175	RES.MF.1/8W.1%.12.1K	RN55D-1212F	TRW	4701-03-1212	2
R163 R31	RES.MF.1/8W.1%.124	RN55D-1240F	TRW	4701-03-1240	2
R38T	RES.MF.1/8W.1%.12.4K	RN55D-1242F	TRW	4701-03-1242	
R231 R264	RES.MF.1/8W.1%.140	RN55D-1400F	TRW	4701-03-1400	2
R132	RES.MF.1/8W.1%.150	RN55D-1500F	TRW	4701-03-1500	1
R114 R117	RES.MF.1/8W.1%.1.5K	RN55D-1501F	TRW	4701-03-1501	2
R168 R173	RES.MF.1/8W.1%.15K	RN55D-1502F	TRW	4701-03-1502	2
R202 R34	RES.MF.1/8W.1%.15	RN55D-15R0F	TRW	4701-03-1509	2
R130	RES.MF.1/8W.1%.1.62K	RN55D-1621F	TRW	4701-03-1621	1
R8	RES.MF.1/8W.1%.182	RN55D-1820F	TRW	4701-03-1820	1
R35T	RES.MF.1/8W.1%.1.96K	RN55D-1961F	TRW	4701-03-1961	1
R142 R144 R146 R158 R210 R214 R243 R249 R30 R32 R73	RES.MF.1/8W.1%.200	RN55D-2000F	TRW	4701-03-2000	11
R223 R40	RES.MF.1/8W.1%.2K	RN55D-2001F	TRW	4701-03-2001	2
R39	RES.MF.1/8W.1%.20K	RN55D-2002F	TRW	4701-03-2002	1
R188	RES.MF.1/8W.1%.215	RN55D-2150F	TRW	4701-03-2150	1
R191 R193	RES.MF.1/8W.1%.21.5K	RN55D-2152F	TRW	4701-03-2152	2

WAVETEK PARTS LIST — TITLE: PCA GENERATOR — ASSEMBLY NO: 1100-00-0834 — REV: A — PAGE 6

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJ MGR		TITLE: PARTS LIST GENERATOR BRD
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX = .010 ANGLES 1 XX = .020		
	DO NOT SCALE DWG		MODEL NO: 190 — DWG NO: 1100-00-0834 — REV
	SCALE		FSCM NO: 23338 — SHEET 1 OF 6

REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY PT
R126 R153	RES.MF.1/8W.1%.221	RN55D-2210F	TRW	4701-03-2210	2
R11 R377 R397	RES MF 1/8W.1%.2.21K	RN55D-2211F	TRW	4701-03-2211	3
R18	RES.MF.1/8W.1%.240	RN55D-2400F	MEPCO	4701-03-2400	1
R20 R232 R233 R234 R265	RES.MF.1/8W.1%.249	RN55D-2490F	TRW	4701-03-2490	5
R147 R157 R215 R225 R66 R70 R91	RES.MF 1/8W 1% 2.49K	RN55D-2491F	TRW	4701-03-2491	7
R107	RES.MF.1/8W.1%.24.9K	RN55D-2492F	TRW	4701-03-2492	1
R17	RES.MF.1/8W.1%.2.74K	RN55D-2741F	TRW	4701-03-2741	1
R160	RES.MF.1/8W.1%.27.4	RN55D-27R4F	TRW	4701-03-2749	1
R194	RES.MF.1/8W.1%.301	RN55D-3010F	TRW	4701-03-3010	1
R110 R183 R49 R50 R7 R79 R92 R99	RES.MF.1/8W.1% 3.01K	RN55D-3011F	TRW	4701-03-3011	8
R212	RES.MF 1/8W 1%.30.1	RN55D-30R1F	TRW	4701-03-3019	1
R259	RES.MF.1/8W.1%.332	RN55D-3320F	TRW	4701-03-3320	1
R19	RES.MF.1/8W.1%.3.32K	RN55D-3321F	TRW	4701-03-3321	1
R58	RES.MF.1/8W.1%.33.2K	RN55D-3322F	TRW	4701-03-3322	1
R181 R263	RES MF 1/8W.1% 33.2	RN55D-33R2F	TRW	4701-03-3329	2
R77 R90	RES.MF.1/8W.1% 3.65K	RN55D-3651F	TRW	4701-03-3651	2

WAVETEK PARTS LIST | TITLE PCA GENERATOR | ASSEMBLY NO 1100-00-0834 | REV A | PAGE 7

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
R87	RES.MF.1/8W.1%.825	RN55D-8250F	TRW	4701-03-8250	1
R60	RES.MF.1/8W.1%.8.25K	RN55D-8251F	TRW	4701-03-8251	1
R101	RES.MF.1/8W.1%.909	RN55D-9090F	TRW	4701-03-9090	1
R108	RES.MF.1/8W.1%.9.09K	RN55D-9091F	TRW	4701-03-9091	1
R154	RES MF 1/8W.1%.90.9	RN55D-90R9F	TRW	4701-03-9099	1
R26	RES MF.1/4W.1%.49.9	RN60D-4989F	TRW	4701-13-4999	1
R235 R236	RES.MF.1/2W.1%.95.3	RN65D-9583F	TRW	4701-23-9539	2
R222 R224	RES.MF.1W.1%.100	RN70D-1000F	TRW	4701-33-1000	2
R237 R238 R239 R241	RES.MF.1W.1%.61.9	RN70D-61R9F	TRW	4701-33-6199	4
R12	RES MODULE	4310R-101-471	BOURN	4770-00-0009	1
R14 R24	RES MODULE	4308R-101-681	BOURN	4770-00-0031	2
R112	RES.MF..6W.1%.10M	ML-181	CADDO	4799-00-0003	1
RV1	VARISTOR	V56ZA8	GE	4799-00-0048	1
CR27	DIODE	1N751A	FAIR	4801-01-0751	1
CR34	DIODE	1N959	SIEM	4801-01-0959	1
CR7	DIODE	1N5282	FAIR	4801-01-5282	1
CR27 CR28	DIODE ZENER 22V	1N5358B	MOT	4801-01-5358	2

WAVETEK PARTS LIST | TITLE PCA GENERATOR | ASSEMBLY NO 1100-00-0834 | REV A | PAGE 9

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY PT
Q1 Q2 Q24 Q27 Q31 Q33	TRANS	2N5771	NSC	4901-03-7710	6
Q7	TRANS	IT 139	INTSL	4902-00-1390	1
Q37 Q38 Q39	TRANS SEL 2N3866 QTY 1 4901-03-8660	4998-00-0051	WVTK	4998-00-0051	3
SW1 SW2 SW3 SW4	SWITCH	5102-00-0009	WVTK	5102-00-0009	4
SW6	SWITCH, 2PDT MOM.	5102-00-0010	WVTK	5102-00-0010	1
SW8	SWITCH 4PDT, P-P	5102-00-0011	WVTK	5102-00-0011	1
NONE	BUTTON CONICAL	F01-01(BLACK)	SHADW	5103-04-0006	2
R161	THERMISTER	LB1272	FNWL	5300-00-0002	1
U9	IC OP-AMP	TL080CP	TI	7000-00-8001	1
U11 13	IC	TL083CN	TI	7000-00-8300	2
U14	IC	LF353N	NSC	7000-03-5300	1
U2	IC OP-AMP	LF356N	NSC	7000-03-5600	1
U3	IC	CA-3019	FAIR	7000-30-1900	1
U8	IC	CA3083	FAIR	7000-30-8300	1
U1	IC	CA3127E	RCA	7000-31-2700	1
U4 U6	IC	MC10102	MOT	8001-01-0200	2
U10 U12	IC	MC1011BP	MOT	8001-01-1600	2

WAVETEK PARTS LIST | TITLE PCA GENERATOR | ASSEMBLY NO 1100-00-0834 | REV A | PAGE 11

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY PT
R132 R149	RES.MF.1/8W.1%.392	RN55D-3920F	TRW	4701-03-3920	2
R176 R33	RES.MF.1/8W.1%.464	RN55D-4640F	TRW	4701-03-4640	2
R131 R141 R22	RES.MF.1/8W.1%.4.64K	RN55D-4641F	TRW	4701-03-4641	3
R44 R57	RES.MF.1.8W.1%.46.4	RN55D-46R4F	TRW	4701-03-4649	2
R120 R129 R155 R207 R250 R41	RES.MF.1/8.1%.499	RN55D-4990F	TRW	4701-03-4990	6
R100 R105 R178 R189 R71 R72	RES.MF.1/8W.1%.4.99K	RN55D-4991F	TRW	4701-03-4991	6
R164 R98	RES.MF.1/8W.1%.49.9K	RN55D-4992F	TRW	4701-03-4992	2
R128 R136 R197 R25	RES.MF.1/8W.1%.51.1	RN55D-51R1F	TRW	4701-03-5119	4
R208 R244	RES.MF.1/8W.1%.59	RN55D-59R0F	TRW	4701-03-5909	2
R70	RES.MF.1/8W.1%.604	RN55D-6040F	TRW	4701-03-6040	1
R145 R184 R209 R242	RES.MF.1/8W.1%.619	RN55D-6190F	TRW	4701-03-6190	4
R240 R266	RES.MF.1/8W.1%.61.9	RN55D-61R9F	TRW	4701-03-6199	2
R115 R116 R122 R123	RES.MF.1/8W.1%.681	RN55D-6810F	TRW	4701-03-6810	4
R13	RES.MF.1/8W.1%.6.81K	RN55D-6811F	TRW	4701-03-6811	1
R179 R195 R261 R42 R43	RES.MF.1/8W.1%.750	RN55D-7500F	TRW	4701-03-7500	5
R246 R47	RES.MF.1/8W.1%.78.7	RN55D-78R7F	TRW	4701-03-7879	2

WAVETEK PARTS LIST | TITLE PCA GENERATOR | ASSEMBLY NO 1100-00-0834 | REV A | PAGE 8

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY PT
CR1 CR2 CR3	DIODE	3N254	MOT	4801-02-0254	3
CR22 CR23 CR24	DIODE	FD777	FAIR	4807-02-0777	3
CR10 CR11 CR12 CR13 CR14 CR16 CR20 CR25 CR26 CR4 CR5	DIODE	1N4148	FAIR	4807-02-6666	11
CR30 CR31 CR8 CR9	DIODE	5082-2811	HP	4809-02-2811	4
CR18 CR19	DIODE SET, 2-FD-777 QTY 2 4807-02-0777	142-301-58	WVTK	4898-00-0003	1
Q34	TRANS	2N2219A	NSC	4901-02-2191	1
Q36	TRANS	2N2369A	MOT	4901-02-3691	2
Q35	TRANS	2N2905A	NSC	4901-02-9051	1
Q12 Q13 Q17 Q18 Q19 Q22 Q23 Q25 Q26 Q28 Q3 Q30 Q32 Q4 Q7 Q8	TRANS	2N3563	FAIR	4901-03-5630	16
Q10	TRANS	2N3646	NSC	4901-03-6460	1
Q29	TRANS	2N3903	NSC	4901-03-9030	1
Q14	TRANS	2N3904	FAIR	4901-03-9040	1
Q15 Q16 Q20 Q21	TRANS	2N3906	FAIR	4901-03-9060	4
Q36 Q40 Q41	TRANS	2N5160-18	MOT	4901-05-1600	3
Q11	TRANS	2N5486	MOT	4901-05-4860	1

WAVETEK PARTS LIST | TITLE PCA GENERATOR | ASSEMBLY NO 1100-00-0834 | REV A | PAGE 10

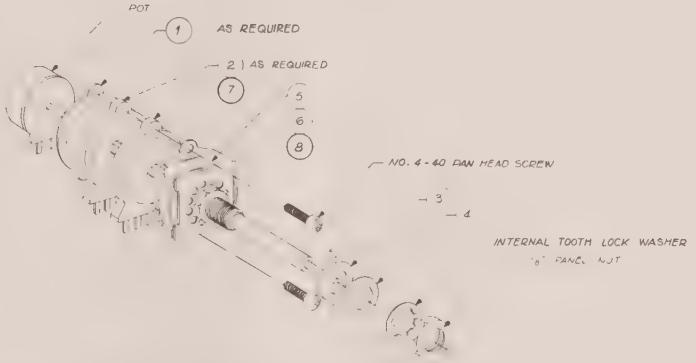
REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY PT
U5	IC	MC10131	MOT	8001-01-3100	1

WAVETEK PARTS LIST | TITLE P.C.A. GENERATOR | ASSEMBLY NO 1100-00-0834 | REV A | PAGE 12

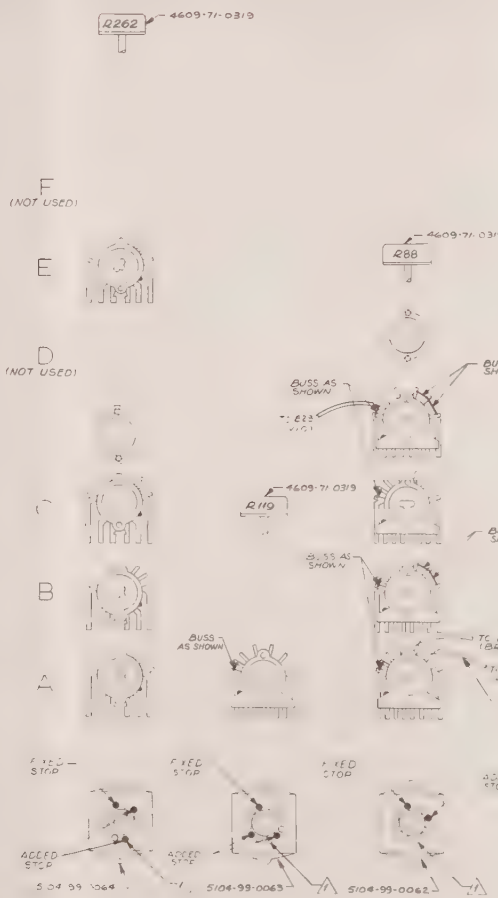
NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJ ENGR		TITLE: PARTS LIST GENERATOR BD
FINISH WAVETEK PROCESS	RELEASE APPROV		
	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES ± 1 XX ± .030		
	DO NOT SCALE DWG	MODEL NO 190	DWG NO 1100-00-0834 REV
	SCALE	CODE IDENT 23338	SHEET 2 OF 2

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION AND DESIGN RIGHTS BELONGING TO WAVETEK AND MAY NOT BE REPRODUCED FOR ANY REASON EXCEPT CALIBRATION, OPERATION AND MAINTENANCE WITHOUT WRITTEN AUTHORIZATION



TYPICAL SWITCH HARDWARE STACK-UP



SW 5 WIRING DETAIL
WAFER A,B,C 4-40 X 3/16" SCREW

SW 7 WIRING DETAIL

SW 9 WIRING DETAIL
WAFER A,B,C,D 4-40 X 1/8" SCREW

4. ALL BUSS WIRE #24 AWG
3. WIRES OBTAINED FROM CHASSIS CABLE KIT 1207-00-0959.
2. ALL WAFERS SHOWN IN CCW POSITION.
1. PLACE DETENT 6 POSITIONS AS SHOWN FROM CCW FIXED STOP BEFORE INSTALLING ADDED STOP.

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES
MATERIAL
FINISH WAVETEK PROCESS
DRAWN FN AQUINO
DATE 11/26/81
PROJECT
RELEASE APPROV
TOLERANCE UNLESS OTHERWISE SPECIFIED .XX .030 ANGLES
DO NOT SCALE DWG
SCALE

WAVETEK

ASSEMBLY SWITCH DETENT GENERATOR BOARD

MODEL NO. 191
DWG NO. 23338
SHEET 1 OF 1

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REFERENCE DESIGNATORS	PART DESCRIPTION	DRIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY. PER
NONE	ASSY DRWG GENERATOR SWITCHES	0102-00-0958	WVTK	0102-00-0958	1
1	PLATE, SW	008-004	WVTK	1400-00-2130	1
R119 R262 R88	POT CONT 10W FROM 4600-01-0312	4609-71-0319	WVTK	4609-71-0319	3
2	WAFER	133-SW1-1	WVTK	5104-02-0008	4
3	WAFER	147-400	WVTK	5104-02-0015	4
4	SWITCH STOP	211-33-001	CTS	5104-07-0001	1
5	SWITCH STOP	212-33-006	CTS	5104-07-0002	3
A	DETENT MOD FROM 5104-01-0010	5104-99-0062	WVTK	5104-99-0062	1
B	DETENT MOD FROM 5104-01-0010	5104-99-0063	WVTK	5104-99-0063	4
8	DETENT, MOD FROM 5104-01-0010	5104-99 0064	WVTK	5104-99-0064	4

WAVETEK PARTS LIST	TITLE ASSY GENERATOR SWITCHES	ASSEMBLY NO 1202-00-0958 PAGE 1	REV

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN / DATE	WAVETEK SAN DIEGO, CALIFORNIA	
MATERIAL	MFG. ENGR	TITLE PARTS LIST GENERATOR SWITCHES	
FINISH WAVETEK PROCESS	MFG. MGR. APPROV.		
	TOLERANCE UNLESS OTHERWISE SPECIFIED .XX ± .010 .XXX ± .030 ANGLES		
	DO NOT SCALE DWG	MODEL NO 190	DWG NO 1202-00-0958 REV
	SCALE	CODE IDENT 23338	SHEET 1 OF 1

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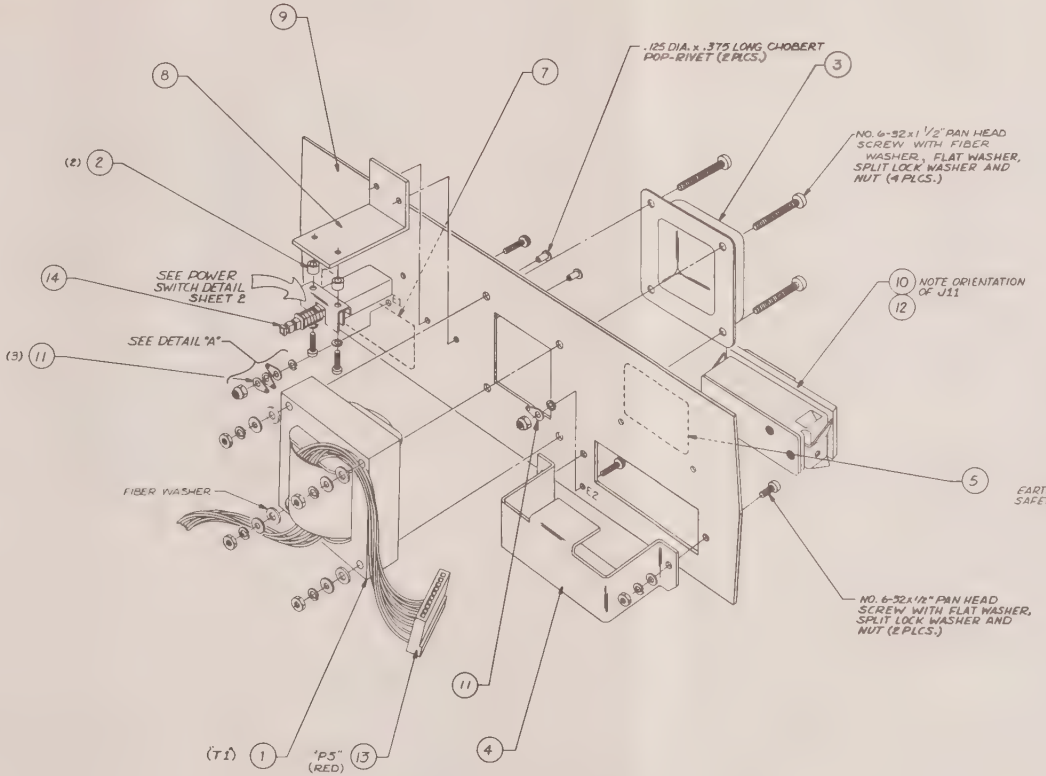
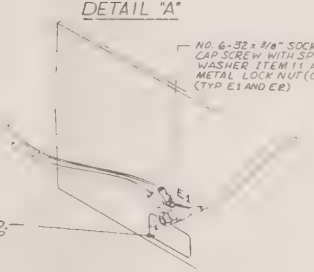
REV	ECN	BY	DATE	APP





2. THIS SHEET IS INTENDED TO SHOW MECHANICAL ASSEMBLY ONLY - REFERENCE SHEET 2 & 2 FOR WIRING.
1. SEE PARTS LIST NO: 1101-00-0957

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES
MATERIAL
FINISH WAVETEK PROCESS
DRAWN D COOPER 10/4/84
ENGINEER
RELEASE APPROV
TOLERANCE UNLESS OTHERWISE SPECIFIED .XX ± .010 .XX ± .005 ANGLES ± 1°
DO NOT SCALE DWG
SCALE

WAVETEK SAN DIEGO, CALIFORNIA

TITLE
ASSEMBLY REAR PANEL (A3)

MODEL NO 190
DWG NO 0102-00-0957
REV
CODE IDENT 23338
SHEET 1 OF 2

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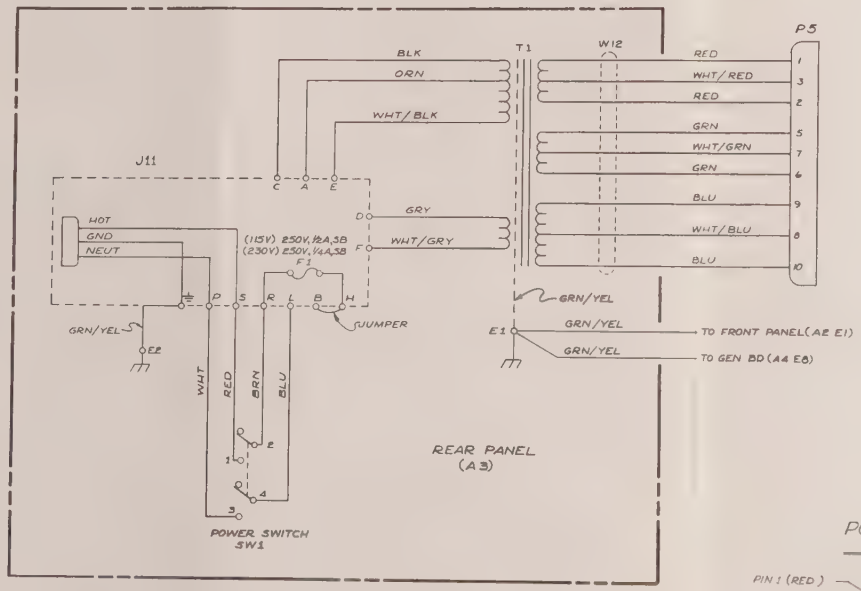
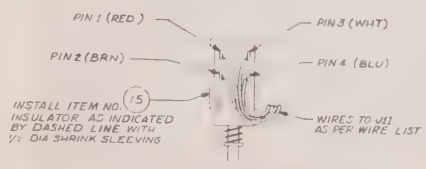
REV	ECN	BY	DATE	APP



WIRE LIST				
AWG	COLOR	LENGTH	DESTINATION FROM	TO
22	RED	5 1/2"	T1	P5-1
22	RED	5 1/2"	T1	P5-2
22	WHT/RED	5 1/2"	T1	P5-3
				P5-4
22	GRN	5 1/2"	T1	P5-5
22	GRN	5 1/2"	T1	P5-6
22	WHT/GRN	5 1/2"	T1	P5-7
22	WHT/BLU	5 1/2"	T1	P5-8
22	BLU	5 1/2"	T1	P5-9
22	BLU	5 1/2"	T1	P5-10
22	GRN/YEL	6"	T1	A3 E1
			(SHIELD)	
24	BLK	7"	T1	J11-C
24	ORN	7"	T1	J11-A
24	WHT/BLK	7"	T1	J11-E
24	GRY	7"	T1	J11-D
24	WHT/GRY	7"	T1	J11-F
22	WHT	8"	J11-P	SW1-3
22	RED	8 1/2"	J11-S	SW1-1
22	BRN	9"	J11-R	SW1-2
22	BLU	9"	J11-L	SW1-4
22	BLU	———	J11-B	J11-H
18	GRN/YEL	9"	J11-H	A3 E2
18	GRN/YEL	11 1/2"	A3 E1	A2 E1
18	GRN/YEL	5 1/2"	A3 E1	A4 E8

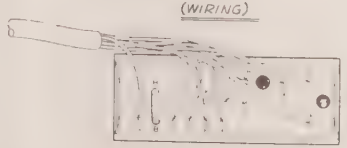
W1, W2 WIRE MARKER 19

POWER SWITCH (WIRING)


PIN 1 (RED)
PIN 2 (BRN)
PIN 3 (WHT)
PIN 4 (BLU)
INSTALL ITEM NO. 15 INSULATOR AS INDICATED BY DASHED LINE WITH 1/2 DIA SHRINK SLEEVING
WIRES TO J11 AS PER WIRE LIST

USE NO.2-56x 1/4" ROUND HEAD SCREW WITH SPLIT LOCK WASHER (2 PLCS) TO INSTALL ON ITEM 5

J11 (WIRING)



1. THIS SHEET IS INTENDED TO SHOW WIRE HOOK UP ONLY - REFERENCE SHEET 1 OF 2 FOR MECHANICAL ASSEMBLY.

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES
MATERIAL
FINISH WAVETEK PROCESS
DRAWN CHERMACK 12/8/82
ENGINEER
RELEASE APPROV
TOLERANCE UNLESS OTHERWISE SPECIFIED XX ± .010 ANGLES ±1° XXX ± .005
DO NOT SCALE DRWG
SCALE

WAVETEK SAN DIEGO, CALIFORNIA

TITLE: ASSEMBLY, REAR PANEL (A3)

MODEL NO. 190
DWG NO. 0102-00-0957
REV
CODE IDENT 23338
SHEET 2 OF 2

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	ORIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
NONE	ASSY DRWG. REAR PANEL	0102-00-0957	WVTK	0102-00-0957	1
1	TRANSFORMER	190-0052	WVTK	1204-00-0052	1
1	END BELL	110-333	WVTK	1400-00-0174	1
4	SPACER	9480	WVTK	1400-00-0653	4
5	LABEL, WARNING	1400-00-6940	WVTK	1400-00-6940	1
15	INSULATOR, PWR SW TCH REF 1600-99-0001	1400-00-8370	WVTK	1400-00-8370	1
1	I.D. LABEL	1400-00-9090	WVTK	1400-00-9090	1
8	BRACKET SWITCH MNTG	1400-01-3263	WVTK	1400-01-3263	1
9	REAR PANEL	1400-01-3822	WVTK	1400-01-3822	
4	SHIELD, VOLTAGE	1400-01-5190	WVTK	1400-01-5190	1
13	HOUSING	1-640433-0	AMP	2100-02-0080	1
10	RECEPTACLE	6VJ1	CORCM	2100-03-0026	1
11	SOLDER LUG	1485-A	SMITH	2100-04-0025	4
12	FUSE, 3/4A, 250V, S-B	313-750	LITFU	2400-03-0011	2
14	SWITCH ASSY PB	5103-00-0020	WVTK	5102-00-0005	1

WAVETEK PARTS LIST	TITLE ASSY. REAR PANEL	ASSEMBLY NO 1101-00-0957 PAGE 1	REV A

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CA. FORM A
MATERIAL	PROGENCE		TITLE PARTS LIST REAR PANEL
FINISH MASTER PROCESS	RELEASE APPROV		
	TOLERANCE UNLESS OTHERWISE SPECIFIED .XX .010 ANGLES ± .XXX .005		
	DO NOT SCALE DWG SCALE	MODEL NO 190	DWG NO 1101-00-0957 REV
		CUSTOMER ORDER NO 23338	SHEET 1 OF 1

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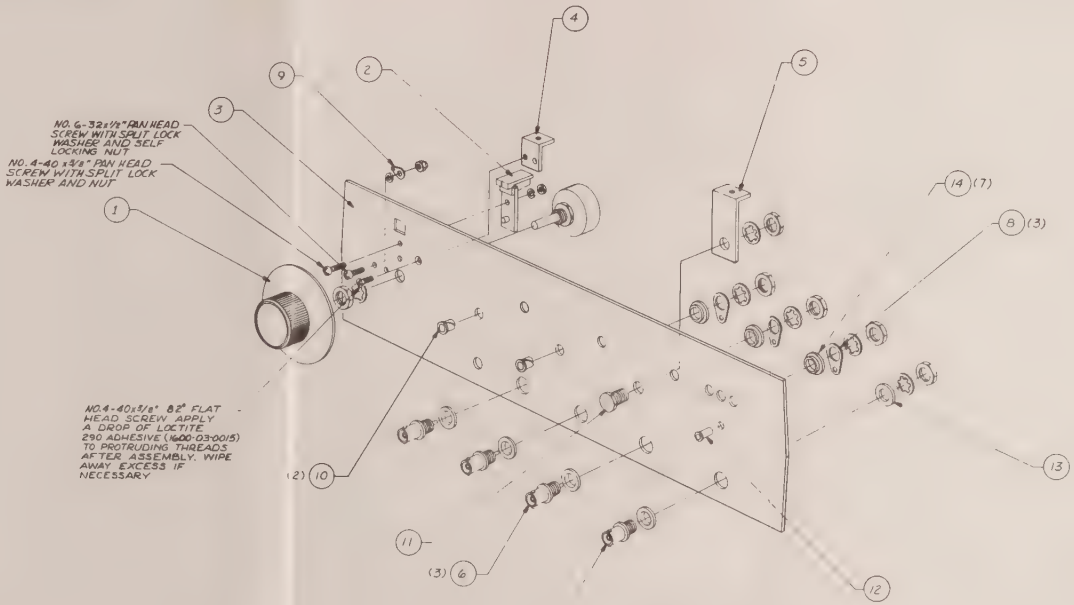
REV	ECN	BY	DATE	APP


NO. 6-32 x 1/4" PAN HEAD SCREW WITH SPLIT LOCK WASHER AND SELF LOCKING NUT
NO. 4-40 x 5/8" PAN HEAD SCREW WITH SPLIT LOCK WASHER AND NUT
NO. 4-40 x 3/8" 82° FLAT HEAD SCREW. APPLY A DROP OF LOCTITE 290 ADHESIVE (1600-03-0015) TO PROTRUDING THREADS AFTER ASSEMBLY. WIPE AWAY EXCESS IF NECESSARY
1
2
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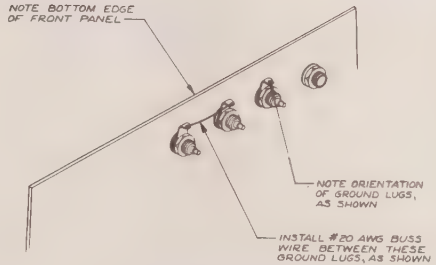
NOTE: P/N 2100-01-0006 BNC SHELL OBTAINED FROM CHASSIS CABLE KIT P/N 1207-00-0959


NOTE BOTTOM EDGE OF FRONT PANEL
NOTE ORIENTATION OF GROUND LUGS, AS SHOWN
INSTALL #20 AWG BUSS WIRE BETWEEN THESE GROUND LUGS, AS SHOWN

BNC GROUND LUG ORIENTATION

1. FOR FRONT PANEL PARTS LIST SEE: 1101-00-0980

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN D. COOPER	DATE	WAVETEK SAN DIEGO, CA 92123
MATERIAL	ENGINEER Ruark Fo	DATE 11-82	TITLE ASSEMBLY FRONT PANEL (A2)
FINISH WAVETEK PROCESS	RELEASE APPROV		
	TOLERANCE UNLESS OTHERWISE SPECIFIED: XXX ± .010 ANGLES ± 1 XX ± .030		MODEL NO 190
	DO NOT SCALE DWG		DWG NO 0102-00-0980 REV
	SCALE		TOOL DWG NO 23338 SHEET 1 OF 1

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REV	ECN	BY	DATE	APP

REFERENCE DESIGNATORS	PART DESCRIPTION	DRIG-MFGR-PART-NO	MFGR	WAVETEK NO.	QTY/PT
NONE	ASSY DRWG. FRONT PANEL	0102-00-0980	WVTK	0102-00-0980	1
1	DIAL ASSY	143-582	WVTK	1201-00-0582	1
2	INDICATOR. DIAL	180-303	WVTK	1400-00-4970	1
3	FRONT PANEL	1400-01-3810	WVTK	1400-01-3810	1
4	ANGLE. PANEL MNTG	1400-01-4523	WVTK	1400-01-4523	1
5	ANGLE. PANEL MNTG	1400-01-4533	WVTK	1400-01-4533	1
6	BNC CONN	KC-7946	KING	2100-01-0002	3
8	SOLDER LUG	1497	SMITH	2100-04-0012	3
9	SOLDER LUG	1485-6	SMITH	2100-04-0025	1
10	BUSHING NYLINER	4L2FF	THOMN	2800-01-0002	2
11	BEARING. PANEL	119	SMITH	2800-01-0004	1
12	BUSHING(NYLINER)1/8	2L2FF	THOMN	2800-01-0003	1
14	WASHER. SHOULDER	2668	SMITH	2800-27-0004	7
13	NYLON FLAT WASHER	2264-N-385	AMTOM	2800-28-0003	1

WAVETEK PARTS LIST	TITLE ASSY. FRONT PANEL	ASSEMBLY NO 1101-00-0980 PAGE 1	REV

NOTE UNLESS OTHERWISE SPECIFIED

REMOVE ALL BURRS AND BREAK SHARP EDGES	DRAWN	DATE	WAVETEK SAN DIEGO, CALIFORNIA
MATERIAL	PROJ ENGR		TITLE PARTS LIST FRONT PANEL
	RELEASE APPROV		
FINISH WAVETEK PROCESS	TOLERANCE UNLESS OTHERWISE SPECIFIED XXX ± .010 ANGLES ± 1 XX ± .030		
	DO NOT SCALE DWG		MODEL NO 190 / DWG NO 1101-00-0980 / REV
	SCALE		CODE IDENT 23338 / SHEET 1 OF 1

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